March 6, 2017

The Registrar
National Electric Power Regulatory Authority (NEPRA),
NEPRA Office Building,
Sector G-5/1,
Ataturk Avenue (East),
Islamabad

Subject: APPLICATION FOR A GENERATION LICENSE

I, Ahmed Ebrahim Hasham, Chief Executive Officer, being the duly authorized representative of **Mehran Energy Limited ("MEL")** by virtue of Resolution of Board of Directors dated January 28, 2017, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to HPPL pursuant to Section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

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

A Bank Draft No. 03150847 dated February 06, 2017 drawn on Bank Al-Habib Limited, in the sum of Rupees 292,896/- (PKR Two Hundred Ninety Two Thousand Eight Hundred Ninety Six) and a Pay Order No. 01558145 dated March 03, 2017 drawn on BankIslami Pakistan Ltd. Rupees 832/- (PKR Eight Hundred Thirty Two only), being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached.

Yours faithfully
For Mehran Energy Limited

Ahmed Ebrahim

Ahmed Ebrahim Hasham
Chief Executive Officer

Executive Tower, Dolmen City, 14-B, 14th Floor, HC-3, Block-4, Marine Drive,
Clifton, Karachi-75600, **Tel** (92-21)35297814-7, **Fax** (92-21)35297818, 35297827
msm@mehransugar.com , www.mehransugar.com

EXTRACTS OF THE RESOLUTIONS OF BOARD OF DIRECTORS OF MEHRAN ENERGY LIMITED PASSED IN THEIR MEETING HELD ON JANUARY 28, 2017 AT REGISTERED OFFICE OF THE COMPANY SITUATED AT EXECUTIVE TOWER, DOLMEN CITY, 14-B, 14TH FLOOR, BLOCK-4, MEHRAN DRIVE CLIFTON, KARACHI.

The Board of Directors of **MEHRAN ENERGY LIMITED** a public limited company duly formed and registered in the Islamic Republic of Pakistan having incorporation No. **A022480** (the **Company**) and having its registered office at **Executive Tower, Dolmen City, 14-B, 14th Floor, Block-4, Mehran Drive Clifton, Karachi**, in their meeting held on **January 28, 2017**, passed the following resolutions:

UNANIMOUSLY RESOLVED that the Company should approach National Electric Power Regulatory Authority (**NEPRA**) for Generation License under the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

Further Resolved, that Mr. Ahmed Ebrahim Hasham, Chief Executive and Mr. Muhammad Hanif Aziz, Company Secretary, of the Company be and are hereby jointly and singly authorized to do any or all of the following acts, deeds and things, on behalf of the Company, in connection with this application to be filed with NEPRA under the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 and the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999:

- Represent the Company before NEPRA, and in doing so perform all lawful acts, deeds and things, including but not limited to filing, signing, presenting, modifying, amending, withdrawing applications and other documents, responding to any queries and meeting any objections, receiving notices and documents; and
- Do all acts, deeds and things, which are ancillary and incidental to the afore-said purposes.

Further Resolved, that extracts of this resolution be provided to the NEPRA with the seal/stamp duly affixed thereon.

Muhammad Hanif Aziz
Company Secretary

Ahmed Ebrahim Hasham
Chief Executive

February 7, 2017

Executive Tower, Dolmen City, 14-B, 14th Floor, HC-3, Block-4, Marine Drive,
Clifton, Karachi-75600, **Tel** (92-21)35297814-7, **Fax** (92-21)35297818, 35297827
www.mehransugar.com

A022480

SECP

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, KARACHI

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No. **0103107**

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

Given under my hand at **Karachi** this **Twenty Sixth** day of **October, Two Thousand** and **Sixteen**.

Incorporation fee Rs. **410,500/=** only

(Zia ul Rasheed Abbasi)
Joint Registrar of Companies
Karachi

Certified to be True Copy

27/X/16

Deputy Registrar of Companies

THE COMPANIES ORDINANCE 1984
(A Company Limited By Shares)

MEMORANDUM OF ASSOCIATION

OF

MEHRAN ENERGY LIMITED

I. The name of the Company is **"MEHRAN ENERGY LIMITED."**

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

III. The objects for which the Company is established are to undertake any or all of the following business in and outside Pakistan.

1. To establish, erect, setup, construct, equip, operate use, manage, maintain and run electric power generating projects and transmission systems for generating power by using wind, fuel, nuclear, thermal, geothermal power station, solar, hydro, coal, steam, indigenous bagasse and/or any other alternative, renewable energy sources and bio-energy to generate electricity and in this regard establish power grid station, switching, conversion, and transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment, transmission towers, buildings, workshops and other facilities as may from time to time be necessary for the attainment of the objects of the company.

2. To carry on the business of establishing operating and managing Electric Power Generating Projects and transmission systems for generating and supplying Electric Power and to manufacture, assemble, acquire and supply all necessary power stations, transmission systems cables, wires, lines, accumulators, lamps and works to generate, accumulate, distribute and supply electricity to customers, both public and private, including but not limited to cities, towns, streets, docks, market theaters, buildings, industries, utilities and places both public and private and for tall other purposes for which energy can be employed.

3. To generate, produce and sell power to utility companies, power distribution networks and organizations in the power sector, within and outside the country.

4. To setup, operate and manage one or more power plants in order to generate, sell and supply electricity to industrial and other consumers, through distribution networks established, owned and operated by the company itself or by any other person, corporate body, autonomous or semiautonomous corporation or authority or local body, and for that purposes to acquire land, whether freehold or leasehold, machinery and equipment, and construct, install, operate and maintain thereon power houses, civil and mechanical works and structures, grid stations, transmission towers power lines, buildings, workshops and other facilities as may from time to time be necessary for the attainment of the objects of the company.

5. To enter into any arrangements with the Government of Pakistan or any local government or with any supreme, national, municipal or local authority, or with any person and place where the Company may have interest that may seem conducive to the Company's objects, or any of them in any mode and to obtain from such government or authority, or other persons any rights, privileges and concessions which the Company may think it desirable to obtain and to carry out, exercise and comply with any such arrangements, rights, privileges and concessions.

6. To produce, refine, sell, supply, market, distribute, transport and otherwise dispose of crude oil, condensate LPG, NGL and Natural Gas and refinery gases and by-products pursuant to any of the objects mentioned in this Memorandum for domestic, commercial or industrial uses or for lighting healing power generation or any other purposes whatsoever.

7. To undertake business in the areas relating to hydel, thermal, solar, energy and wind power installations, controls, protection, communication and instrumentation system for power plant, substations, industrial installation and pumping compressor stations, energy conversion system.

8. To offer and to engage in supply, implementation and installation of EHV and HV transmission lines, medium and low voltage overhead and underground distributions network, high voltage underground cables, and low voltage AC and DC installations, rectifier, capacitor installations and consumer services.

9. To act as electrical/mechanical/civil work contractors to local and foreign Governments, agencies, authorities, municipalities, autonomous corporations, private and public companies in power sector.

10. To borrow, procure, raise money in local or any foreign currency from banks, financial institutions, non-banking finance companies, group company(ies) and or avail finances under any Islamic financing scheme and to borrow, procure, or to secure the money in such manner as the Company may deem fit and particularly by mortgage or hypothecation of its property in full or in part or both the present and future assets or by the issue of shares, stocks, bonds, debentures, Participation Term Certificates, Term Finance Certificates, or any other form of redeemable capital or securities charged or based upon the undertaking of the Company, or any part of its property, both present and future and generally to borrow or procure money for the purposes of the business of the Company in such manner as the Company may deem fit, including by issue of debentures, bonds, securities, Participation Term Certificates, Term Finance Certificates, either permanent or redeemable or repayable or convertible into shares and to secure any securities of the Company by a trust or other assurances.

11. To purchase, take on lease or in exchange, hire, apply for or otherwise acquire and hold for any interest, any rights, privileges, lands, building, easements, trademarks, patents, patent rights, copyrights, licences, and any movable and

immovable property of any kind necessary or convenient for the purposes of or in connection with the Company's business or any branch or department thereof and to use, exercise, develop, grant licences in respect of or otherwise turn to account any property, rights and information so acquired, subject to any permission required under the law.

12. To open accounts with any Bank or Banks and to draw, make, accept, endorse, execute, issue, negotiate and discount cheques, promissory notes, bills of exchange, bills of lading, warrants, deposit notes, debentures, letter of credit and other negotiable instruments and securities.

13. To own, establish, run and maintain offices, branches and agencies all over Pakistan or elsewhere for the development of business of the Company.

14. To invest surplus money of the Company in shares, stocks or securities of any company, debentures, debenture stocks or in any investments, short term and long term participation, term finance certificates or any other Government Securities in such manner as may from time to time be decided by the Directors and in accordance with the relevant laws applicable in Pakistan, without indulging into non-banking finance business, banking business or an investment company or any other any unlawful business.

15. To guarantee the performance of contracts, agreements, obligations or discharge of any debt of the Company or on behalf of any other company or person subject to the provisions of Section 195 of the Companies Ordinance, 1984 in relation to the payment of any financial facility including but not limited to loans, advances, letters of credit or other obligations through creation of any or all types of mortgages, charges, pledges, hypothecations, on execution of the usual banking documents or instruments or otherwise encumbrance on any or all of the movable and immovable properties of the Company, either present or future or both and issuance of any other securities or sureties by any mean in favour of banks, Non-Banking Finance Companies (NBFCs) or any Financial Institutions and to borrow money for the purposes of the Company on such terms and conditions as may be considered proper.

16. To enter into arrangements with the Government or Authority (Supreme, Municipal, Local or otherwise) or any corporation, company, or persons that may seem conducive to the Company's objects or any of them and to obtain from any such Government, Authority, Corporation, company or person any charters, contracts, rights, privileges and commission which the Company may think desirable and to carry on exercise and comply with any such charters, contracts, decrees, rights, privileges and concessions.

17. To sell, transfer, mortgage, pledge, exchange or otherwise dispose of the whole or any part of the property or the undertaking of the Company, either together or in portions for such consideration as the Company may think fit and in particular, for shares, debenture-stock or securities of any Company purchasing the same or to any other legal entity or person, by other means, permissible under the law.

18. To sell, transfer, mortgage, pledge, exchange or otherwise dispose of the whole or any part of the property or the undertaking of the Company, either together or in portions for such consideration as the Company may think fit and in particular, for shares, debenture-stock or securities of any Company purchasing the same or to any other legal entity or person, by other means, permissible under the law.

19. To carry out joint venture agreements with other companies or countries within the scope of the objects of the Company.

20. To make known and give publicity to the business and products of the Company by any means the Company may think fit.

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

22. To go in for, buy or otherwise acquire and use any patent design, copyright, licence, concession, convenience, innovation, invention, trademarks, rights, privileges and the like in Pakistan or elsewhere, which may for the time being appear to be useful or valuable for adding to the efficiency or productivity of the Company's business, as permissible under the law.

23. To establish, promote or assist in establishing or promoting and subscribe to or become a member of any other company, association or firm whose objects are similar or in part similar to the objects of this Company or the establishment or promotion of which may be beneficial to the Company, as permissible under the law.

24. To establish and support or aid in the establishment and support of associations, institutions, funds and conveniences calculated to benefit the directors employees, ex-employees of the Company or any dependent thereof and to grant pensions, gratuities, allowances, relief and payments in any manner calculated to benefit the persons described herein.

25. To apply for and obtain necessary consents, permissions and licences from any Government, State, Local and other Authorities for enabling the Company to carry on any of its objects into effect as and when required by law.

26. To cause the Company to be registered or recognized in any foreign country and carry on its business activities in any part of the world.

27. To create provident fund, gratuity fund, pension fund, reserve fund, sinking fund, insurance fund, or any other special fund conducive to the interest of the Company.

28. To capitalize such portion of the profits, accumulated profits or reserves of the Company as are not distributed amongst shareholders of the Company in the form of dividend and as the Directors of the Company may think fit, to issue bonus shares as fully paid-up in favour of the shareholders of the Company.

29. To remunerate Directors, officials, servants of the Company or any other person or firm or company rendering services to this Company, out of, or in proportion to the returns or profits of the Company or otherwise as the Company may think proper, either by cash payment and/or by the allotment to him or them shares or securities of the Company credited as paid up in full as may be thought expedient in accordance with the laws to which the Company may be subject.

30. To amalgamate, merge with, absorb, reconstruct, de-merge, acquire or take over any other company or the whole or part of any undertaking having objects altogether or in part similar to those of the Company or carrying on any business capable of being conducted so as directly or indirectly to benefit this Company, whether by sale or purchase of the assets, property or undertaking, or divestiture of the whole or part of the undertaking of the Company or by partnership or any arrangement in the nature of partnership or in any other manner or to enter into and carry into effect any arrangement, or for sharing of profits, with any partnership undertaking or person carrying on business within the objects of this Company.

31. To do and perform all other acts and things as are incidental or conducive to the attainment of the objects of the Company.

32. To adopt such means (both in and outside Pakistan) of promotion, marketing and making known and advertising the products and services of the Company as may seem expedient subject to the laws to which the Company may be subject.

33. Nothing contained herein shall be construed to empower the Company to engage in banking business in any form and manner whatsoever or business relating to brokerage, finance, leasing or the business of any investment company, or as investment advisor, insurance company or the business of financial institution or in any unlawful business and that nothing in the objects clause shall be construed to entitle it to engage in such business. The Company shall not launch multilevel marketing, pyramid and ponzi schemes.

34. It is, hereby, undertaken that the Company shall not engage in banking business or Forex, illegal brokerage, or any business of investment company or non-banking finance company or insurance or leasing or business of managing agency or in any unlawful business and that nothing contained in the object clauses shall be so construed to entitle it to engage in such business directly or indirectly and the Company shall not launch multi-level marketing (MLM), Pyramid and Ponzi schemes.

35. Notwithstanding anything stated in any objects clause, the Company shall obtain such other approval or license from Competent Authority, as may be required under any law or the time being in force, to undertake a particular business.

IV. The liability of the members is limited.

V. The Authorized Share Capital of the Company is **Rs. 100,000,000/- (Rupees One Hundred Million Only)** divided into **10,000,000 (Ten Million)** shares of **Rs. 10/- (Ten)**, each, comprising of such classes and kinds as my be permissible under the Companies Ordinance, 1984 or any other statutory enactment or modification thereof or instrument as may for the time being be applicable to the Company.

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

Name and surname with father's/husband's name (present & former name) in full and block Letter	Nationality with any former nationality	Occupation	Residential address in full	Number of shares taken by each subscriber	Signature
Mr. Ahmed Ebrahim Hasham S/o. Mohammed Ebrahim Hasham CNIC# 42301-0892695-1	Pakistani	Business	92/A/17, CF-1-5, Clifton, Karachi.	01 (One)	
Mr. Mohammed Hussain Hasham S/o. Haji Hasham CNIC# 42301-0961271-7	Pakistani	Business	92/A/18, CF-1-5, Clifton, Karachi.	01 (One)	
Mr. Khurram Kasim S/o. Mohammed Kasim CNIC# 42301-0866868-7	Pakistani	Business	92/A/16, CF-1-5, Clifton, Karachi.	01 (One)	
				03 **(Three)**	

Dated this 17th day of OCTOBER 2016

WITNESS TO ABOVE SIGNATURES:

Full Name: NIFT Pvt. Ltd. Signature : _____

Full Address: 5th Floor, AWT Plaza, I.I. Chundrigar Road, Karachi. 74200

5964

Certified to be True Copy

Deputy Registrar of Companies

Securities & Exchange Commission of Pakistan * Company Registration Office * Karachi

THE COMPANIES ORDINANCE, 1984
(COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

OF

MEHRAN ENERGY LIMITED

PRELIMINARY

1. The regulations contained in Table `A' in the First Schedule to the Companies Ordinance, 1984 shall not apply to the Company except is so far as the same are reproduced, contained or deemed to be contained in or expressly made applicable by these Articles or the Ordinance. **Table `A' not to apply**

2. The marginal notes hereto shall not effect the construction hereof in these Presents, unless there be something in the subject or context inconsistent therewith. **Interpretation**

"The Articles" means these Articles of Association as originally framed or as from time to time altered by Special Resolution. **`The Articles'**

"The Board" means the Board of Directors of the Company for the time being. **`The Board'**

"The Company" means **MEHRAN ENERGY LIMITED.** **`The Company' or `this Company**

"The Chief Executive" means the Managing Director of the Company, by whatever name called appointed pursuant to Section 198 of the Ordinance. **`The Chief Executive'**

"The Chairman" means the Chairman of the Board of the Company, appointed from time to time pursuant to these Articles. **`The Chairman'**

"The Directors" means the Directors for the time being of the Company including Alternate directors for the time being of the Company. **`The Directors'**

"Dividend" includes bonus. **`Dividend'**

"Financial Statements" means a balance sheet, profit and loss account, cash flow statement, statement showing changes in equity, accounting policies and explanatory notes."	**`Financial Statements'**
"In writing" and "Written" includes printing, litho-graphy, typewriting and other modes of representing or reproducing words in a visible form.	**`In writing' and `written'**
"Member" means member of the company in accordance with the provisions of Section 2(1)(21) of the Ordinance.	**`Member'**
"Month" means calendar month.	**`Month'**
"The Ordinance" means the Companies Ordinance, 1984 or any statutory modification or re-enactment thereof for the time being in force.	**`The Ordinance'**
"The Office" means the Registered Office for the time being of the Company.	**`The Office'**
"Proxy" includes an attorney duly constituted under a power of attorney.	**`Proxy'**
"Person" includes the Government of Pakistan, the Government of the Provinces, Corporations, Associations, Bodies Corporate as well as individuals.	**`Person'**
"The Registrar" means a Registrar, an Additional Registrar, a Joint Registrar, a deputy Registrar or an Assistant Registrar of Companies.	**`The Registrar'**
"The Register" means the Register of Members to be kept pursuant to Section 147 of the Ordinance.	**`The Register'**
"The Redeemable Capital" means the Redeemable Capital as defied in the Ordinance.	**`The Redeemable Capital**
"Special Resolution" has the same meaning as is assigned thereto by Section 2 (1)(36) of the Ordinance.	**`Special Resolution'**
"The Secretary" means the Secretary for the time being of the Company.	**`The Secretary'**
"The Seal" means the Common Seal of the Company.	**`Seal'**
Words importing the singular number shall include the plural number and vice versa.	**`Singular' and `plural number'**

Words importing the masculine gender shall include the feminine gender. **'Gender'**

Unless the context otherwise requires, words or expressions contained in these articles shall bear the same meaning as in the Ordinance or any Statutory modification thereof in force at the date at which these articles become binding on the Company.

BUSINESS

3. The Company shall not commence or exercise borrowing powers until a certificate of commencement of business has been obtained as required by the Ordinance. **Business**

CAPITAL

4. The authorized capital of the Company is **Rs. 100,000,000/- (Rupees One Hundred Million Only)** divided into **10,000,000 (Ten Million)** shares of **Rs. 10/- (Ten)** each. The **"minimum subscription"** within the meaning of the Ordinance shall be **Rs. 100,000/-.** **Authorized Capital**

5. The Directors may, with the sanction of the Company in general meeting, increase the authorized share capital by such sum as the resolution may prescribe, subject nevertheless to the provisions of Section 92 of the Ordinance. Variations, including abrogation, revocation or enhancement in the rights of holders of shares of any class shall be effected only in accordance with the provisions of Section 28 and 108 of the Ordinance. **Alteration of Authorized Capital**

6. The directors shall, as regards any allotment of shares, duly comply with such of the provisions of Section 68 to 73, as may be applicable thereto. **Return as to allotments**

7. The new shares consistent with the provisions of the Ordinance shall be issued upon such terms and conditions and with such rights and privileges annexed thereto, as the resolution passed in a general meeting creating the same shall direct and if no direction be given, as the Directors shall determine. **How far new shares to rank with shares of original capital**

8. The Company may increase the capital of the Company by the issue of further shares and may decide to whom such shares shall be offered and in absence of such determination, the shares shall be under the control of the Directors who may allot or otherwise dispose off the same to such persons, on such terms and conditions and at such times, as the Directors, subject to the provisions of Section 86 of the Ordinance, may deem fit and subject to Section 73(1)(b) to give to any person for such consideration as the Board deems fit, in payment or part payment for any property sold or transferred, goods or machinery supplied or for services rendered to the Company in or about the formation or promotion of the Company or the conduct of its business or in satisfaction of any **Further issue of Capital**

outstanding debt or obligation of the Company, and with power to issue shares either at par or at premium and, subject to the provisions of the Ordinance, at a discount, provided always that upon the issue of further shares, the Directors shall, offer such shares to the members in proportion to the existing shares held by each member and such offer shall be made by notice specifying the number of shares to which a member is entitled and limiting a time within which the offer if not accepted will be deemed to be declined and after the expiration of such time or on receipt of information from the member to whom such notice is given that he declines to accept the same, the directors may dispose off such shares as provided in Section 86 of the Ordinance. The new shares shall be subject to the same provisions with reference to transfer, transmission and otherwise as the shares in the original share capital.

Sub-division or consolidation of shares

9. Resolution by which any share is sub-divided or consolidated may subject to provisions of Section 90 and 92 of the Ordinance determine that as between holders of shares resulting from sub-division or consolidation, rights of profits, votes and other benefit attaching to them will be proportionate to their paid up value and where shares issued or sub-divided or consolidated, shares are of same class as those previously issued, the rights attaching to them, subject as aforesaid, shall be the same as those attaching to the shares previously held.

Reduction of Capital and how carried into effect

10. Subject to the provisions of the Ordinance, the Company may from time to time by Special Resolution reduce its share capital in any way and in particular (without prejudice to the generality of the power) by paying off capital or cancelling capital which has been lost or is unrepresented by available assets or reducing the liability on the shares or otherwise as may seem expedient and capital may be paid off upon the footing that it may be called up again or otherwise, and paid up capital may be cancelled as aforesaid without reducing the nominal amount of the shares by the like amount to the extent that the unpaid and callable capital shall be increased by the like amount.

11. Except to the extent permitted by the Ordinance, no part of the funds of the Company shall be employed in the purchase of any shares of the Company, and the Company shall not give, whether directly or indirectly, and whether by means of a loan, guarantee, the provision of security or otherwise, any financial assistance for the purchase of or in connection with a purchase made or to be made by any person of any shares of the Company or give any loan upon the security of any shares of the Company.

Loans, advances for and purchase of company's shares prohibited

SHARES

12. Shares may be registered in the name of any individual, limited company or other body corporate but not in the name of minor or a firm. Not more than four persons shall be registered as joint-holders of any shares.

Persons in whose name shares to be registered

13. If any share stands in the name of two or more persons, the person first named in the Register shall, as regards receipt of dividend or bonus or services of notice, and all or any other matters connected with the Company except the transfer of shares, be deemed the shareholder.

The first named of joint holders of shares

14. In the case of the death of any one or more of the persons named in the Register as the joint-holders of any share, the survivor or survivors shall be the only person or persons recognized by the Company as having any title to or interest in such share, but nothing herein contained shall be taken to release the estate of a joint-holder from any liability on shares held by him jointly with any other person.

Death of one or more of joint holders of shares

15. Every shareholder shall name to the Company an address and such address shall for all purposes be deemed to be his registered address.

Shareholders to give address

CERTIFICATE

16. Every person whose name is entered as a Member in the Register shall without payment be entitled to receive, after allotment or registration of transfer, one certificate for all his shares or several certificates each for one or more of his shares and upon payment of such charges, if any, as the Directors may determine for every certificate after the first.

Member's right to certificate

17. The certificate of title of shares and duplicates thereof when necessary shall be issued under the seal of the Company and signed by two Directors, or by one Director and the Secretary.

Certificates

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

Only one certificate for each share

19. The Company shall, within ninety days, after the allotment of any of its shares, and within forty five days after the date on which the application for the registration of transfer has been lodged, complete and have ready for delivery the certificates of all shares, allotted or transferred, and shall serve notice to the shareholder, unless the conditions of issue of the shares otherwise provide.

Delivery of certificate

20. If any certificate be worn out, defaced, destroyed or lost or if there is no further space on the back thereof for endorsement of transfer, it may be renewed or replaced on payment of such fee, not exceeding five rupees, as the Directors may from time to time prescribe, provided, however, that such new certificate shall not be granted except upon delivery of the worn out or defaced or used up certificate for the purpose of cancellation or upon proof of destruction or loss to the satisfaction of the Directors and on such indemnity as the Directors may deem adequate in case of certificate having been lost or destroyed. Any renewed certificates shall be marked as such.

Replacement of Certificate

21. If and whenever as a result of an issue of new shares or any consolidation or sub-division of shares any member becomes entitled to hold shares in fraction, the Directors shall not be required to issue such fractional shares and shall be entitled to sell these shares at a reasonable price and pay and distribute to and amongst the members entitled to such fractional shares in due proportion the net proceeds of the sale thereof.

Proceeds from fractional shares

22. For the purpose of giving effect to any sale under Article 21 the Directors may authorize any person to transfer the shares sold to the purchaser thereof, and the purchaser shall be registered as the holder of the shares comprised in any such transfer, and he shall not be entitled to see the application of the purchase money nor shall his title to the shares be affected by any irregularity or invalidity in the proceedings in reference to the sale.

Sale of whole shares in lieu of fractional amount

COMMISSION AND BROKERAGE

23. The Company may, subject to the Ordinance, at any time, pay commission or brokerage to any person for subscribing or agreeing to subscribe (whether absolutely or conditionally) for any shares or securities of the Company, or procuring or agreeing to procure such subscriptions (whether absolute or conditional).

Commission and Brokerage

24. The Company may issue ordinary shares or grant option to convert into ordinary shares against loans, indebtedness, debenture and/or redeemable capital or other security in the manner provided in Section 87 of the Ordinance.

Shares in lieu of debentures, etc.

TRANSFER AND TRANSMISSION OF SHARES

Restriction on transfer

25. Subject to the provisions of the Ordinance, no transfer of shares shall be registered unless a proper instrument duly stamped and executed by the transferor and the transferee has been delivered to the Company together with the certificate or certificates of the shares. The instrument of transfer of any shares shall be signed both by the transferor and transferee and shall contain the name and address of the transferor and transferee. The transferor shall be deemed to remain the holder of such share until the name of the transferee is entered in the Register in respect thereof. Each signature to such transfer shall be duly attested by the signature of one witness who shall add his address and occupation.

Time limit for registering transfer

26. Upon the re-lodgement of instruments of transfer duly rectified from defect or the invalidity, the Company shall within 45 days thereof, register such transfer in favour of the transferee, if satisfied as to the validity of the transfer in all material respects.

27. Application for the registration if shares may be made either by the transferor or the transferee and subject to the provisions of Article 26 hereof, the Company shall enter into register of members the name of the transferee in the same manner and subject to the same condition as if application for registration was made by the transferee.

Notice of refusal to register

28. If the Directors refuse to register the transfer of any shares they shall within one month from the date on which the transfer was lodged with the Company send to the transferee and the transferor notice of such refusal.

Evidence of transmission and powers to refuse registration of transmission

29. Every transmission of share shall, if so required by the Directors, be evidenced by an instrument of transmission in such form and shall be verified in such manner as the Directors may require. The Directors may decline to register any such transmission unless it shall be in such form and so verified and the regulations of the Company complied with. All instruments of transmission which shall be registered shall remain in the custody of the Company for such period as the Directors may determine. Any instrument of transmission which the Directors may decline to register or act upon shall be returned to the person depositing the same.

Form of transfer

30. The transfer of shares shall be effected by an instrument in writing in the usual common form modified so as to suit the circumstances of the parties and shall be executed both by the transferor and transferee and duly stamped according to law. Execution be attested by at least one witness who shall add his address and occupation and the transferor shall be deemed to remain the holder of such shares until the names of transferee shall have been entered in the Register of members in respect hereof.

31. Every instrument of transfer shall be left at the office for registration, duly stamped, accompanied by the certificate of the shares to be transferred and such other evidence as the Company may require to prove the title of the transferor or his right to transfer the shares. All instruments of transfer which will be registered shall be retained by the Company. Any instrument of transfer which the Directors may decline to register shall, on demand, be returned to the person depositing the same.

Transfer to be left at office and evidence of title given

32. Where it is proved to the satisfaction of the Directors that an instrument of transfer duly signed by the transferor and the transferee has been lost, the company may, if the Directors shall think fit, by an application in writing made by the transferee and bearing the stamps required by an instrument of transfer, register the transfer on such terms as to indemnify as the Director may think fit.

Registration of transfer when instrument of transfer is lost

33. No fee will be charged for registering transfer of shares.

Fee for transfer

34. The transfer books and register of members may be closed for any time or times not exceeding in the whole forty-five days in each year, but not exceeding thirty days at a time, in accordance with the manner specified in Section 151 of the Ordinance.

Books and register may be closed

35. Nominee, if any, appointed under the provisions of Section 80 of the Ordinance, or legal representative of a deceased member shall be the only person recognised by the Company as having title to his share. In case of joint-holders, the surviving holders or the executors or administrators of the last surviving holders shall be the only person entitled to be so recognised. The Company shall not be bound to recognise such nominee or legal representative except as provided in Section 80 of the Ordinance unless he shall have obtained probate or letters of administration or other legal representation, as the case may be, from a duly constituted court in Pakistan or from any court or authority authorized by an Act of the legislature or by any order or notification of the Central or Provincial Government, to grant such probate or letters of administration. Provided nevertheless that in special cases, and in such cases only, it shall be lawful for the Directors to dispense with the production of probate or letters of administration or such other legal representation upon such terms as to indemnity or otherwise as the Directors may deem fit.

Nomination and share of deceased members

36. The Company shall incur no liability or responsibility whatsoever in consequence of their registering or giving effect to any transfer of shares made or purporting to be made by an apparent legal owner thereof to the prejudice of persons having or claiming any equitable right, title or interest to or in the same notwithstanding that the Company may have had notice of such equitable right, title or interest, or notice prohibiting registration of such transfer, and may have entered such notice or referred thereto in any book of the Company and shall not be bound or required to

Company may not recognize equitable rights in shares

attend, or give effect to any notice, which may be given to them of any equitable right, title or interest or be under any liability whatsoever for refusing or neglecting so to do, though it may have been entered or referred to in some book of the Company. The Company shall nevertheless be at liberty to regard and attend to any such notice and give effect thereto if the Directors shall so think fit.

GENERAL MEETINGS

General meeting

37. A General Meeting to be called annual general meeting shall be held, in accordance with the provisions of Section 158, within eighteen months from the date of incorporation of the Company and thereafter once at least in every calendar year within a period of four months following the close of its financial year and not more than fifteen months after the holding of its last preceding annual general meeting, a general meeting shall be held on date, time and place as may be determined by the Directors.

Statutory Meeting

38. The statutory meeting of the Company shall be held in the manner, for the purpose and within the period required by Section 157 of the Ordinance.

When an extraordinary meeting to be called

39. The Directors may, whenever they think fit, and shall on the requisition of the holders of not less than 10% of the issued capital of the Company, forthwith proceed to convene an Extra-Ordinary General Meeting of the Company and in case of such requisition, the provisions of Section 159 of the Ordinance shall apply.

NOTICE OF MEETING

Notice of Meeting

40. Subject to the provisions of Section 158 and 159 of the Ordinance twenty-one days notice at least (exclusive of the day on which the notice is served or deemed to be served, but inclusive of the day for which notice is given) specifying the place, the day and the hour of meeting. In case of special business the general nature of that business shall be given in the manner hereinafter provided or in such other manner, if any, as may be prescribed by the Company in general meeting or in the manner provided by the Ordinance, to such persons as are under the Ordinance or under these Articles, entitled to receive such notice from the Company.

Omission to give notice not to invalidate proceedings

41. An accidental omission to give notice of a meeting to or the non-receipt of notice of a meeting, by any person entitled to receive notice shall not invalidate the proceedings of the meeting.

42. With the consent in writing of all the members entitled to receive notice of a particular meeting, that meeting may be convened by such shorter notice and in such manner as those members may deem fit subject to approval application of Directors by the Registrar of Companies.

Meeting by a shorter notice

PROCEEDINGS AT GENERAL MEETINGS

43. The business of an annual general meeting shall be to receive and consider the financial statements and the reports of the Directors and of the Auditors, to elect Directors, to declare dividends and to appoint Auditors and fix their remuneration. All other business transacted at an annual general meeting, shall be deemed special.

Special Business

44. No business shall be transacted at any general meeting unless a quorum of meeting is present at the time when the meeting proceeds to business and throughout its proceedings. Subject to the provisions of Section 160(2)(a) of the Ordinance, four members personally or by proxy present at the meeting shall be a quorum representing in the aggregate not less than twenty five percent of the total voting power of the Company.

Quorum

45. If within half an hour from the time appointed for the meeting a quorum is not present, the meeting shall stand adjourned to date, time and place to be determined and at the adjourned meeting the members present being not less than two shall be a quorum.

Quorum within half an hour

46. The Chairman if any, of the Board of Directors shall preside as Chairman at every general meeting of the Company, or if there is no such Chairman, or if he shall not be present within fifteen minutes after the time appointed for the holding of the meeting or is unwilling to act, the Directors present shall elect one of their member to be Chairman of the meeting, or if no Director be present or if Directors present decline to take the chair, the members present shall choose one of their number to be Chairman of the meeting.

Chairman to preside

47. The Chairman may with the consent of any meeting at which a quorum is present (and shall if so directed by the meeting), adjourn the meeting from time to time and from place to place, but no business shall be transacted at any adjourned meeting than the business left unfinished at the meeting from which the adjournment took place.

Adjournment by Chairman

48. At a general meeting, a resolution put to the vote shall be decided on a show of hands, unless a poll is (before or on the declaration of the show of hands) demanded in accordance with the provisions of Section 167 of the Ordinance as follows:

Poll when demanded

a) by the Chairman of the meeting of his own motion; or
b) by at least five members having the right to vote on the resolution and present in person or proxy;

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

d) by any member or members present in person or by proxy and holding shares in the company conferring a right to vote on the resolution, being shares on which an aggregate sum has been paid up which is not less than one-tenth of the total sum paid up on all the shares conferring that right.

Unless a poll is so demanded, a declaration by the Chairman of the meeting that a resolution has on a show of hands been carried or carried unanimously or by a particular majority, or lost, and an entry to that effect in the book containing the minutes of the proceedings of the Company, shall be conclusive evidence of the fact without proof of the number or proportion of the votes recorded in favour of or against such resolution.

Poll

49. If a poll is demanded on any matter other than the election of a Chairman or on a question of adjoumment, it shall be taken in accordance with the manner laid down in Section 168 of the Ordinance at such time, not more than fourteen days from the day on which it is demanded, as the Chairman of the meeting may direct.

The results of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded. The demand for a poll may be withdrawn at any time by the person or persons who made the demand.

Other business to continue

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

Chairman's decision conclusive

51. The Chairman of any meeting shall be the sole judge of the validity of every vote tendered at such meetings. The Chairman present at the taking of poll shall be the sole judge of the validity of every vote tendered at such poll.

VOTES OF MEMBERS

Votes of members

52. On a poll every member present in person or by proxy shall have one vote in respect of each share held by him. On a show of hands every member present in person or by proxy shall have one vote.

Rights of senior members to vote

53. In the case of joint-holders the vote of the senior member present whether in person or by proxy shall be accepted to the exclusion of the votes of the other joint-holders, and for this purpose seniority shall be determined by the order in which their names stand in the register.

54. A member of unsound mind, or in respect of whom an order has been made by any court having jurisdiction in lunacy, may vote, whether on a show of hands or on a poll, by his committee or other legal guardian and any such committee or guardian may, on a poll, vote by proxy.

Vote in respect of shares of members of unsound mind

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

Objection to qualification of votes to be raised at the meeting

56. On a poll, votes may be given either personally or by proxy.

How votes to be given on a poll

57. The instrument appointing a proxy shall be in writing under the hand of the appointer or of his attorney duly authorized in writing, or, if the appointer is body corporate, corporation or company, either under its common seal or under the hand of an officer or attorney duly authorized.

Instrument of proxy how made

58. The instrument appointing a proxy and the power of attorney or other authority (if any) under which it is signed or a notarially certified copy of that power or authority shall be deposited at the office not less than forty-eight hours before the time for holding the meeting at which the person named in the instrument proposes to vote, and in default the instrument of proxy shall not be treated as valid.

Time for depositing proxy at office

59. An instrument appointing a proxy may be in the following form, or in any other form which the Directors shall approve:

Form of proxy

I/We _____ S/o. D/o.W/o. _____ of _____ being a member of **Mehran Energy Limited (the Company)** and holder of _____ Shares as per Share Register Folio No. _____ and hereby appoint _____
(Name)
of _____
(full address)
or failing him/her _____
(Name)
of _____
(full address)

as my /our proxy to attend, speak and vote for me/us and on my/our behalf, at the _____Annual General Meeting / Extra Ordinary General Meeting of the Company to be held on _____, at _____ and at any adjournment thereof.

As witnessed given under my/our hand(s) _____day of _____.

1. **Witness:**
Signature_____
Name_____

Affix Revenue Stamps of 5/-

NIC No._____
Address_____

_____
Signature of Members

2. **Witness:**
Signature_____ Shareholder's Folio No. _____
Name _____ NIC No._____
NIC No. _____
Address_____

Dated:_____

60. The instrument appointing a proxy shall be deemed to confer authority to demand or join in demand for a poll. **Effect of proxy**

61. A vote given in accordance with the terms of an instrument of proxy shall be valid notwithstanding the previous death or insanity of the principal or revocation of the proxy or of the authority under which the proxy was executed, or the transfer of the shares in respect of which the proxy is given, provided that no intimation in writing of such death, insanity revocation or transfer, as aforesaid shall have been received by the Company at the office before the commencement of the meeting or adjourned meeting at which the proxy is used. **When vote by proxy valid though authority revoked**

62. Any corporation or body corporate which is a member of the Company may by resolution of its Directors or other governing body authorize such person as it thinks fit, to act as its representative at any meeting of the Company or of any class of members of the Company and the persons so authorized shall be entitled to exercise the same powers on behalf of the corporation which he represents as that corporation could exercise if it were an individual member of the Company, present in person. A corporation attending a meeting through such representative shall be deemed to be present at the meeting in person. **Member Corporation may appoint representative**

DIRECTORS

63. The number of directors to be elected shall be fixed according to the provisions of Section 178 of the Ordinance subject to the condition that until otherwise determined, the number of directors to be elected in accordance with the provisions of the Ordinance shall not be less than three and more than twelve. In addition to the Directors elected or deemed to have been elected by shareholders, the Company may have, subject to the provisions of the Ordinance, directors nominated by the Company's creditors or other special interest by virtue of contractual arrangements. **Number of directors**

64. The following shall be the first directors of the Company:

First Directors

1. **Mr. Ahmed Ebrahim Hasham**
2. **Mr. Mohammed Hussain Hasham**
3. **Mr. Khurram Kasim**

All the first director(s) who are subject to retirement in terms of the provisions of the Ordinance, shall hold office until the election of directors in the first annual general meeting unless any of them earlier resigns, becomes disqualified as a director or otherwise ceases to hold office.

65. Notwithstanding the provision of these Articles, the appointment, election, tenure of office and removal of Directors shall be made and/ or carried out in accordance with provisions of the Ordinance. Subject to the provision of Section 178 of the Ordinance the Directors shall be elected by the Members in general meeting from amongst the candidates eligible for election in the following manner:

Election of directors

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

b) The number of votes calculated in accordance with the preceding clause (a) may be given to a single candidate or may be divided between any two or more candidates in such manner as the person voting may choose; and

c) The candidate who gets the highest number of votes shall be declared elected as Director and then the candidate who gets the next highest number of votes shall be so declared and so on until the total number of Directors to be elected has been so elected.

66. Any person who seeks to contest an election to the office of Director shall, whether he is a retiring Director or otherwise, file with the Company, not later than fourteen days before the date of meeting at which elections are to be held, a notice of his intention to offer himself for election as a Director, provided that any such person may, at any time, before the holding of elections withdraw such notice.

Notice for election as a director

67. Save as provided in section 187 of the Ordinance, no person shall be appointed as a director unless he is a member of the Company.

Directors to be members

68. Retiring Directors shall continue to perform their functions until their successors are elected.

Retiring directors continue to perform functions

69. A Director elected by the members in general meeting shall hold office for a period of three years following the date from which his election is effective unless he earlier resigns, becomes disqualified for being a Director or otherwise ceases to hold office.

Term of office of director

70. The remuneration of a Director, shall, from time to time be determined by the Board and unless otherwise determined shall not exceed Rs.500/- per meeting at which the Directors shall be present from the commencement till the end of the meeting. The Directors shall be paid such travelling, boarding, lodging and other expenses properly incurred by them in or about the performance of their duties or business if any of them has to come to attend the Board or general meeting of the Company from outstation.

Remuneration of a director

71. Any Director appointed to any executive office including for the purpose of this Article the office of Chief Executive, Chairman, or to serve on any Committee or to devote special attention to the business of the Company or who otherwise performs extra services, which in the opinion of the Directors are outside the scope of the ordinary duties of the Directors, may be paid such extra remuneration by way of salary, fees, percentage of profits or otherwise as shall from time to time be determined by the Board of Directors and be subject to provisions of any law for the time being in force applicable to the Company.

Special remuneration to directors for performing extra duties

72. Subject to the provisions of Section 181 of the Ordinance, the Company may at any time, by resolution in general meeting, remove a director, appointed under Section 176 or Section 180 or elected in the manner provided for in Section 178 but no such resolution shall be deemed to have been passed if the number of votes cast against it is equal to or exceeds:

Removal of director

i) the minimum number of votes that were cast for the election of a director at the immediately preceding election of directors, if the resolution relates to the removal of director elected under sub-section (5) of Section 178; or
ii) the total number of votes for the time being computed in the manner laid down in sub-section (5) of Section 178 divided by the number of directors for the time being, if the resolution relates to removal of director appointed under Section 176 or Section 180.

73. Any casual vacancy occurring among the elected directors may be filled up by the directors, but a person so appointed in lieu of an elected director shall hold office for the remainder of term of the director in whose place he is appointed. Before filling in any casual vacancy on the Board, the directors, shall in writing notify their intention of filling such vacancy to the member or members, if any, whose interest were represented by the director vacating office and shall fix a term of not less than fourteen clear

Casual vacancy to be filled by directors

days during which such member or members may recommend (jointly if there are two or more members) a candidate for appointment as Director to fill vacancy. If the member or members concerned recommend a candidate in writing within the term prescribed, the directors may appoint him as director to fill the casual vacancy but upon such recommendation being made no person, other than the candidate recommended by such member or members, may be appointed by the directors to fill the casual vacancy on the Board.

Alternate director

74. Any director who intends to be, or is absent for a period of not less than three (3) months from Pakistan, he may with the approval of the Board (such approval not to be unreasonably withheld) nominate any person to be his Alternate director. Particulars of such nomination should be filed with the Secretary of the Company. Such Alternate director during the absence of the appointer from Pakistan, shall be entitled to receive notice of and to attend and vote at meeting of directors and shall be subject to the provisions contained in these Articles. He may exercise and perform all such powers, directions and duties as his appointer could have exercised or performed including the power of appointing another Alternate director. An Alternate director so appointed shall not be entitled to receive any remuneration from the Company nor be required to hold any qualification. Such appointment shall be recorded in the directors minutes book. A director may at any time by notice in writing to the Company remove an alternate director appointed by him upon his return to the district where the Company's meetings are normally held, or on the death of, or retirement or resignation as director of the Company, the Alternate director shall cease to be such provided that if any director retires but is re-elected at the meeting at which such retirement took effect, an appointment made by him pursuant to this Article which was in force immediately prior to his retirement and re-election and which has not otherwise ceased to be effective, shall continue to operate after his re-election as if he had not so retired. An Alternate director shall not be deemed to be the agent of the director appointing him but shall be reckoned as one with his appointer. All appointments and removals of alternate directors shall be effected by writing under the hand of the director making or revoking such appointment and left at the office of the Company. For the purpose of assessing a quorum in accordance with the provisions of Article 91 hereof, an alternate director shall be deemed to be a director. Any director may act as an Alternate director for any one or more directors, as well as being able to act as a director in his own right. An alternate director may resign as such upon giving thirty (30) days prior notice in writing to the Board to this effect. An Alternate director need not be a member of the Company.

Nominated directors

75. The company may have Directors nominated by any financial institution or a bank or consortium (hereinafter called institution). Where such institution requires appointment of its nominee as a Director under the terms of granting loans, redeemable capital, subscribing to the

Company's debentures or debenture-stock, making bridge financing, or under stipulations that a loan granted shall be converted into shares at the option of either party to the contract or otherwise, such Director shall act as a Director at the pleasure of the institution appointing him. Such Director may be called "Institutional Director" or "Creditor Director" or prefixed by the name of nominating institution. Such Director shall neither be required to hold any qualification shares nor shall be subject to the provisions relating to retirement, removal, qualification, disqualification of directors, but shall have same rights and privileges and be subject to the same obligations as other Directors of the Company. Institutions nominating a Director may require withdrawal or removal of such Director or upon resignation or death of such Director, such institutions shall have the right to nominate another person in his place.

Chairman

76. The directors shall elect from amongst themselves from time to time a Chairman of the Board. In the event position of the Chairman falls vacant or he is held by the Board as not being able to carry out the duties of his office satisfactorily, the Board shall revoke his appointment and appoint a person to be the Chairman of the Board. The Chairman of the meeting shall be the sole judge of the validity of every vote tendered at such meetings. The Chairman shall have a casting or second vote.

Executive committee of directors

77. The Directors may from time to time delegate any of their powers to a committee or committees consisting of 3 (three) or more members of their body as they think fit. Any committee so formed shall conform to any regulations that may be imposed upon it by the Directors and shall be governed, in the exercise of the powers so delegated, by the provisions herein contained for regulating meeting and proceedings applicable to the Directors.

POWERS AND DUTIES OF DIRECTORS

General powers of directors

78. The business of the Company shall be managed by the Directors, who may pay all expenses incurred in setting up and registering the Company. The Directors may exercise all such powers of the Company as are not by the Ordinance or any statutory modification thereof for the time being in force, or by any other law or these Articles, required to be exercised by the Company in general meeting. But no regulation made by the Company in general meeting shall invalidate any prior act of the Directors which would have been valid if that regulation had not been made.

Borrowing powers of directors

79. The Directors may subject to any limitation or restrictions as they may deem fit to impose from time to time exercise all the powers of the Company to borrow money and to mortgage or charge its undertaking, property, or any part thereof, and to issue securities and debentures whether outright or as security for any debt, liability or obligations of the Company or of any third party.

Power to appoint attorneys

80. The Directors may from time to time and at any time by power of attorney appoint any company, firm or person or body of persons, whether nominated directly or indirectly by the Directors, to be the attorney or attorneys of the Company for such purposes and with such powers, authorities and discretion (not exceeding those vested in or exercisable by the Directors under these Articles) for such period and subject to such conditions if any as they may think fit. The powers of attorney may contain such provisions for the protection and convenience of persons dealing with any such attorney to delegate all or any of the powers, authorities and discretion vested in him.

Directors may hold office of profit

81. A Director of the Company or a firm of which such Director is a partner or a private company in which such Director is a Director or member may with the consent of the Company in general meeting hold any office of profit in the Company.

Directors may make contract with the Company

82. Subject to the provisions of the Ordinance, the Directors shall not be disqualified from contracting with the Company either as vendor, purchaser, or otherwise, nor shall any such contract or agreement entered into by or on behalf of the Company with any company or partnership or in which any Director of the Company shall be a member or otherwise interested be avoided nor shall any such Director so contracting or being such member or so interested, be liable to account to the Company for any profit realized by any such contract or arrangement by reason of such Director holding that office or of the fiduciary relation thereby established. However, the nature of his interest shall be disclosed by him at the meeting of the Directors at which the contract or arrangement is determined on, if the interest then exists, or in any other case at the first meeting of the Directors after the acquisition of the interest. A General Notice that any Director of the Company is a Director or a member of any other company or is a member of any named firm and is to be regarded as interest in any subsequent transaction with such company or firm shall as regards any such transaction be sufficient disclosure under this Article. Subject to the provision of Section 214 of the Ordinance, after any such general notice it shall not be necessary to give any special notice relating to any particular transaction with such firm or company. In the case of a contract for the appointment of a manager of the Company, the provisions of Section 218 of the Ordinance shall be observed and performed.

Register of contract with directors

83. In accordance with the provisions of Section 219 of the Ordinance, a Register shall be kept by the Directors in which shall be entered particulars of all contracts or arrangements to which Article 83 applies and which shall be open to inspection by any member at the office during business hours.

Manner of signing certain documents

84. All cheques, promissory notes, drafts, bills of exchange and other negotiable instruments, and all receipts for moneys paid to the Company, shall be signed, drawn, accepted, endorsed or otherwise executed, as the

case may be, in such manner as the Directors shall from time to time by resolution determine.

Directors to comply with the law

85. The Directors shall duly comply with the provisions of the Ordinance or any statutory modification thereof for the time being in force. In particular with the provisions in regard to the registration of the particulars of mortgages and charges affecting the property of the Company or created by it. Keep a Register of the Directors and Managers and send to the Registrar all returns and statements required under the Ordinance, and in particular an annual list of members and a summary of particulars relating thereto and notice of any consolidation or increase of share capital, or conversion of shares into stock and copies of special resolutions and a copy of the Register of Directors, officers, chief executive, secretary, chief accountant, auditors and legal advisers and any changes therein.

Directors to cause minute books to be maintained

86. The Directors shall cause minutes to be made in books provided for the purpose :

a) of all appointments of officers made by the Directors;
b) of the names of the Directors present at each meeting of the Directors and of Committee of Directors;
c) of all resolutions and proceedings of all meetings of the Company, and of the Directors and of Committee of Directors;

and every Director present at any meeting of Directors or Committee of Directors shall sign his name in a book to be kept for the purpose. Any such minutes of such a meeting if purporting to be signed by the Chairman thereof, or by the Chairman of the next succeeding meeting of the same body, shall be sufficient evidence without any further proof of the fact therein stated.

DISQUALIFICATION OF DIRECTORS

Vacation of office of director

87. The office of Director shall be vacated if:-

a) he is ineligible on any one or more grounds enumerated in Section 187 of the Ordinance;

b) he absents himself from three consecutive meetings of the Directors or from all meetings of the Directors for a continuous period of three months whichever is the longer without leave of absence from the Board of Directors;

c) he or any firm of which he is a partner or any private company of which he is a director without the sanction of the Company in general meeting accepts or holds any office of profit under the Company other than that of chief executive or a legal or technical

adviser or a banker;

d) he is found to be of unsound mind by a court of competent jurisdiction;

e) he is adjudged an insolvent;

f) he acts in contravention of Section 195 of the Ordinance;

g) he has been convicted by the Court of competent jurisdiction for an offence involving moral turpitude;

h) he resigns his office by notice in writing to the Company;

i) he has betrayed lack of fiduciary behavior and a declaration to this effect has been made by the Court under Section 217 of the Ordinance;

j) he has been declared by a Court of competent jurisdiction as defaulter in repayment of loan to a financial institution, exceeding such amount as may be notified by the Securities and Exchange Commission of Pakistan from time to time;

PROCEEDINGS OF DIRECTORS

Directors may regulate meetings

88. The directors may meet together for the dispatch of business, adjourn or otherwise regulate their meetings, as they think fit. A Director may, and the Secretary on the requisition of a Director shall, at any time, summon a meeting of Directors. It shall not be necessary to give notice of meeting of directors to any director for the time being absent from Pakistan.

Quorum

89. The quorum necessary for the transaction of the business of the Directors may be fixed by the Company in general meeting and unless so fixed shall be not less than one-third of the number of directors for the time being or four whichever be higher. For the purposes of this Article, an Alternate director appointed by a director shall be counted in a quorum at a meeting at which the Director appointing him is not present.

Matters to be decided by majority vote

90. All questions arising at any meeting of Directors shall be decided by a majority of votes. In the case of an equality of votes, the Chairman of the meeting shall have a second or casting vote.

Procedure of continuing directors when there are vacancies to be

91. The continuing Directors may act notwithstanding any vacancy in their body, but if and so long as their number is reduced below the number fixed by or pursuant to the regulations of the Company as the necessary quorum of Directors, the continuing Directors may act for the purpose of filling vacancies in their body or summoning a general meeting of the

Company, but for no other purpose. **filled**

92. All acts done at any meeting of the Directors or by any person acting as a Director notwithstanding that it shall afterwards be discovered that there was some defect in the appointment or continuance in office of any such Director or person acting as aforesaid, or that they or any of them were disqualified or had vacated office, or were not entitled to vote, be as valid as if every such person had been duly appointed or had duly continued in office and qualified and had continued to be a Director and had been entitled to be a Director. **Acts of directors to be valid if defect discovered afterward**

93. Subject to the provisions of the Ordinance, a resolution consented to in writing or by e-mail, telex, telegram or facsimile signed by all of the Directors or their alternatives, shall be as valid and effectual as if it has been passed at a meeting of the Directors duly called and constituted. The consent may be in the form of counterparts. **Resolution by circulation**

94. If at any meeting the Chairman is absent, Directors may elect any Director to act as the Chairman of the meeting. **Election of chairman for the meeting**

CHIEF EXECUTIVE

95. The Directors shall within 14 days of the constitution of the Board or from the date of election of directors or the office of the Chief Executive falling vacant, as the case may be, appoint, subject to the provisions of Section 198 of the Ordinance, a Chief Executive of the Company, for a period of three years. The Board may revoke such appointment and appoint another person in place of the Chief Executive so removed or who may vacate office by reason of death, resignation or otherwise as the case may be. **Company to have chief executive**

96.(a) The period for which the Chief Executive shall be appointed shall not exceed three years unless he ceases to hold office or a shorter time of appointment is fixed by the directors, or he earlier resigns or his services as Chief Executive has been terminated by the Board in accordance with the provisions of the Ordinance. On the expiry of his term of office, the Chief Executive shall be eligible for re-appointment in the manner provided in these Articles or in accordance with the provisions of the Ordinance. The terms and conditions of appointment of the Chief Executive, including his powers, duties, obligations and remuneration, shall be determined by the Board, subject to the provisions of the Ordinance and these Articles. **Tenure of chief executive**

(b) The Board shall have the powers to assess the performance of the Chief Executive every year and shall replace the Chief Executive, if his performance is found unsatisfactory in the opinion of the Board.

(c) The Chief Executive shall hold office, enjoy and exercise such powers, duties, obligations and privileges as the Board may confer upon him from time to time and shall accordingly in exercise of such powers delegated to him, conform to any limits and restrictions which may be imposed by the Board from time to time in this respect. The Chief Executive may exercise all such powers and do all acts and things on behalf of the Company as he may be authorized to do by the Board.

Terms, conditions, power & duties of chief executive

97. The Chief Executive shall be entitled to remuneration and benefits commensurate with his performance, which determination shall be made by the Board.

Emoluments of the chief executive

98. The Chief Executive may be removed in accordance with the provisions of Section 202 of the Ordinance.

Removal of chief executive

SECRETARY

99. A Secretary may be appointed by the Directors for such term, at such remuneration and upon such conditions as they may think fit, and any Secretary so appointed may be removed by them. Where there is no Secretary capable of acting, the Directors may appoint an Assistant or Deputy Secretary or any other officer of the Company to perform the duties of Secretary.

Secretary

THE SEAL

100. The Directors shall provide for the safe custody of the seal which shall only be used by the authority of the Directors, and every instrument to which the seal shall be affixed shall either be signed by one Director and countersigned by Secretary or by a Second Director or by some other person appointed by the Directors for the purpose.

Common seal of the Company

DIVIDENDS AND RESERVES

101. The Company in general meeting may declare a dividend, but no dividend shall exceed the amount recommended by the Directors.

Company may declare a dividend

102. No dividend shall be paid by the Company otherwise than out of profits or reserves of the Company or in contravention of Section 248(2) of the Ordinance.

Dividend Payable from Profits only

103. The Directors may from time to time pay to the members such interim dividend as appear to the Directors to be justified by the profits of the Company.

Interim dividend

104. The profits of the Company available for appropriation/distribution after making such provisions and transfers to reserve as shall be required to meet expenses or anticipated expenses of the Company, subject to the provisions of the Ordinance, be appropriated and distributed periodically

Reserve fund

and/or annually by way of dividend, subject to the development needs and liquidity position of the Company as recommended/determined by the Board, in full to the members of the Company in proportion to their respective shareholding.

Dividends to shareholder, indebted to the company

105. When any shareholder is indebted to the Company, all dividends payable to him or a sufficient part thereof, may be retained and applied by the Directors in or towards satisfaction of the debt.

Payment of dividends

106. Any dividend, interest or other moneys payable in cash in respect of shares may be paid by cheque or warrant sent through the post direct to the registered address of the holder or, in the case of joint-holders, to the registered address of that one of the joint-holders who is first named in the Register or to such persons and to such address as the holder or joint-holders may in writing direct. Every such cheque or warrant shall be made payable to the order of the person to whom it is sent. Any two or more joint-holders may give effectual receipt for any dividends, bonuses, or other moneys payable in respect of the shares held by them as joint-holders. The dividend shall be paid within the period laid down in Section 251 of the Ordinance.

Unpaid dividend shall not bear interest

107. Unpaid dividends shall not bear interest against the Company.

CAPITALIZATION OF PROFITS

Capitalization of profits

108. The Company in general meeting may upon the recommendation of the Directors resolve that it is desirable to capitalize any part for the time being of the Company's reserves or accumulated profits or otherwise available for distribution, and accordingly that such sum be set free for distribution amongst the members who would be entitled thereto if distributed by way of dividend and in the same proportion on condition that the same be not paid in cash but be applied in paying up in full un-issued shares as bonus shares of the Company to be allotted and distributed/credited as fully paid up to and amongst such members in the proportion aforesaid, or partly in the one way and partly in the other, and the Directors shall give effect to such resolution.

ACCOUNTS

Books of account

109. The Directors shall cause proper books of account to be kept as required by Section 230 of the Ordinance.

Location of books of account

110. The books of account shall be kept at the registered office of the Company or at such other place as the Directors shall deem fit and shall be open to inspection by the Directors during business hours.

Inspection of books of account

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

Preparation of financial statements and reports

112. The Directors shall, as required by Sections 233, 234 and 236, cause to be prepared and to be laid before the Company in general meeting such financial statements duly audited and reports as are referred to in those sections.

Presentation of financial statements and report before the general meeting

113. The financial statements and other reports referred to in regulation 112 shall be made out in every year and laid before in the Company's annual general meeting made up to a date not more than four months before such meeting. The financial statements shall be accompanied by a report of the auditors of the Company and the report of Directors.

Directors' reports

114. The financial statements shall be audited by the Auditors of the Company and shall subject to the provisions of Section 236 of the Ordinance be accompanied by a report of the Directors as to the state and condition of the Company, and as to the amount which they recommend to be paid out of the profits by way of dividends to the Members, and the amount, if any, which they propose to carry to one or more reserves according to the provisions in that behalf herein contained. Every report of the Directors, shall be signed by the Directors in accordance with Sections 236 and 241 of the Ordinance.

Copy of balance sheet and reports to be served on registered holder

115. A copy of the financial statements together with reports of directors and auditors shall, atleast twenty one days preceding the annual general meeting, be sent to the persons entitled to receive notices of general meetings, in the manner in which notices are to be given hereunder and a copy thereof shall be deposited at the registered office of the Company for the inspection of members for a period of twenty one days prior to such meeting.

AUDIT

Auditors

116. Auditors shall be appointed and their duties regulated in accordance with Sections 252 to 255 of the Ordinance or any statutory modifications thereof for the time being in force.

117. Any of the Directors may at his sole cost and expense, inspect any books of account or document (save and except any documents containing secret information which the Company is under any obligation not to divulge or disclose to any party) and cause to conduct an independent audit of the Company upon giving 10 (ten) days prior notice to the Board

and any report arising from such audit shall be distributed to all directors of the Company.

NOTICES

How notice to be served on members

118. A notice may be given by the Company to any member either personally or by sending it by post, courier, e-mail, telefax or telex to his registered address. Where a notice is sent in any manner aforesaid, service of the notice shall be deemed to be effected by properly addressing, prepaying and posting, delivering, transmitting, as the case may be, a letter containing the notice and unless the contrary is proved, to have been effected at the time at which the letter would be delivered in the ordinary course of post/delivery.

Notice to joint holders

119. A notice may be given by the Company to the joint-holders of a share by giving the notice to the joint-holder named first in the Register in respect of the share and a notice so given shall be sufficient notice to all the holders of such shares.

Notice to persons entitled by transmission

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

Notice of general meeting

121. Notice of every general meeting shall be given in the manner herein before authorized to (a) every member of the Company, except those members who have no registered address or have not supplied to the Company an address for the giving of notice to them, and also (b) every person entitled to a share in consequence of the death or insolvency of a member, who but for his death or insolvency would be entitled to receive notice of the meeting.

Division of assets

122(1) Subject to the provisions of the Ordinance, if the Company is wound up, the liquidator may, with the sanction of a special resolution of the Company and any other sanction required by the Ordinance, divide amongst the members, in specie or kind the whole or any part of the assets of the Company, whether they consist of property of the same kind or not.

(2) For the purpose aforesaid, the liquidator may set such value as he deems fair upon any property to be divided as aforesaid and may determine how such division shall be carried out as between the members or different classes of members.

(3) The liquidator may, with the like sanction vest the whole or any part of such assets in trustees upon such trusts for the benefit of the contributories as the liquidator, with the like sanction, thinks fit, but so that no members shall be compelled to accept any shares or other securities whereon there is any liability.

SECRECY

Secrecy

123. Save as otherwise provided in the Ordinance no member or other person (not being a Director) shall be entitled to visit and inspect any of the Company's premises or properties of the Company without the permission of the Directors of the Company for the time being or any person authorized in this behalf by the Directors or to require discovery of or information respecting any detail of the Company's trading or any matter whatsoever which may relate to the conduct of the business of the Company and which in the opinion of the Directors will be expedient in the interest of the members of the Company to be communicated to the public.

DISPUTE RESOLUTION

Dispute resolution

124. In the event that a dispute, claim or controversy arises between the Company, its management or its shareholders, or between the shareholders inter-se, or the directors inter-se, all steps shall be taken to settle the dispute and resolve the issue through mediation by an accredited mediator before taking recourse to formal dispute resolution such as arbitration or litigation.

INDEMNITY

Indemnity

125. Every Director or officer of the Company and every person employed by the Company as auditors shall be indemnified out of the funds of the Company against all liability incurred by him as such Director, officer or auditor in defending any proceedings, whether civil or criminal, in which judgement is given in his favour, or in which he is acquitted, or in connection with any application under Section 488 of the Ordinance in which relief is granted to him by the court or otherwise permitted by law.

ARBITRATION

Arbitration

126. Whenever any difference arises between the Company on the one hand, and any of the members, their executors, administrators, or assigns on the other hand, touching the true intent or construction, or the incidents or consequences of these presents, or of the statutes, or touching anything then or thereafter done, executed, omitted or suffered in alleged breach of these presents, or any claim on account of any such breach or alleged breach, or otherwise relating to the premises, or to these presents, or to any statute affecting the Company, or to any of the affairs of the Company, every such difference shall be referred under the Arbitration Act 1940, to the decision of an arbitrator to be appointed by the parties in differences, or if they cannot agree upon a single arbitrator, to the decision of two arbitrators, of whom one shall be appointed by each of the parties in difference, or an umpire to be appointed by the two arbitrators. The cost of, and incident to, any such reference and award shall be in the discretion of the arbitrators, or umpire respectively, who may determine the amount thereof, or direct the same to be taxed as between attorney and client or otherwise, and may award by whom, and to whom, and in what manner the same shall be borne and paid.

MISCELLANEOUS

Companies ordinance to prevail

127. If the provisions of these Articles are in any way inconsistent with the provisions of the Companies Ordinance, 1984 or any other law for the time being in force, the provisions of that Ordinance or that other law shall prevail, and these Articles shall be read subject to that Ordinance or that other Law.

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

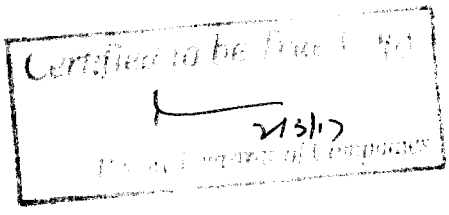
Name and surname with father's/husband's name (present & former name) in full and block Letter	Nationality with any former nationality	Occupation	Residential address in full	Number of shares taken by each subscriber	Signature
Mr. Ahmed Ebrahim Hasham S/o. Mohammed Ebrahim Hasham CNIC# 42301-0892695-1	Pakistani	Business	92/A/17, CF-1-5, Clifton, Karachi.	01 (One)	
Mr. Mohammed Hussain Hasham S/o. Haji Hasham CNIC# 42301-0961271-7	Pakistani	Business	92/A/18, CF-1-5, Clifton, Karachi.	01 (One)	
Mr. Khurram Kasim S/o. Mohammed Kasim CNIC# 42301-0866868-7	Pakistani	Business	92/A/16, CF-1-5, Clifton, Karachi.	01 (One)	
				03 **(Three)**	

Dated this 17th day of OCTOBER 2016

WITNESS TO ABOVE SIGNATURES:

Full Name: NIFT Pvt. Ltd. Signature : _____

Full Address: 5th Floor, AWT Plaza, I.I. Chundrigar Road, Karachi. 74200



Technology, Type and Model

1.1 General Design

The design of the Facility is typical for a biomass-fired cogeneration facility which also is specific to the use of bagasse and to the cogeneration requirements.

The boilers will consist of tall water wall furnace with platen generators located at the top of the furnace. The super heater will have three stages. The first stage is a horizontal tube convective super heater located in the boiler second pass. The second stage consists of platens located at the top of the furnace adjacent to the generator section. The third stage consists of pendants located above the furnace arch between the second and first stages. Following the super heater will be three horizontal tube economizer sections and four tubular air heater sections.

The steam cycle consists of two high pressure feed water heaters and a deaerator for each unit. The high-pressure feed water heaters take steam from the two uncontrolled extractions of the steam turbine. Steam for the deaerator is to be supplied from the controlled extraction of the steam turbine.

The Facility has two modes of operation defined by steam needs of MSML. During the crushing season, MSML needs steam and electricity to crush the sugar cane and produce sugar. Steam for MSML will be supplied from the controlled extraction of the steam turbine which is at approximately 2.5 bar pressure. The expected steam demand for MSML is 88 tons/hr. The electricity demand during the crushing season is 11.967 MW. During the off-season, the electricity demand is 0.5 MW.

1.2 Technology

Combustion technology based on the Rankine Cycle will be utilized in this project which is proven to be the latest technology. The bagasse will be combusted in a high-pressure boiler and the steam generated will be fed to the steam turbine to generate power. The turbine will be different from the conventional thermal power plants as the turbine will be provided with a controlled extraction for extracting the process steam required for the sugar mill. To enhance the efficiency of operation, regenerative heaters are used in the feed water circuit. For the cogeneration power plant proposed for MEL, the cogeneration cycle is based on the parameters of 110 bar(a) and 540 degree centigrade at the boiler outlet, currently being used in many countries for the cogeneration projects. The cycle chosen with the above parameters is the latest used in many of the bagasse fired installations around the world. These above selected parameters make the cycle more efficient and help in the generation of more units for the same quantum of the fuel.

There are already many Cogeneration plants operating in Pakistan & India with these parameters and the operating experience of those plants, in synchronization with the sugar mill operation, has been smooth and without any hitch. The Cogeneration scheme for MEL proposes 1x135 TPH capacity boilers and 1x26.5 MW extraction condensing turbo generators. Considering the offseason operation of the plant, the Cogeneration power plant boilers will be designed for firing the saved bagasse and a few other compatible bio-mass fuels.

2 Design and Specifications of the Plant

2.1 Bagasse Fired Boiler

The Boiler shall be single drum, natural circulation, radiant furnace with water cooled membrane wall, three stage super-heater with two stage attemperator, balanced draft and travelling grate bagasse fired boiler. The boiler is capable of a peak generation of 110% of the MCR for a period of half an hour in eight-hour shift. The boiler shall be top supported, outdoor type, with adequate provisions for the thermal expansion of the boilers in all directions.

Design Parameters:

- Bagasse Fired Boiler; 135 TPH
- Steam pressure at the Main Steam stop valve outlet: 110 bar(a)
- Steam temperature at the Main steam stop valve outlet at MCR: 540 ± 5 ^{0}C
- Boiler feed water temperature at the inlet to the Deareator: 210 ^{0}C.
- Maximum noise level at 1.0 m distance for the boiler: 85 dB(A)
- Maximum noise level at 1.0 m for boiler drum safety valves: 85 dB(A)

The Bagasse through drum feeders, screw feeders and pneumatic spreaders will be fed into the furnace. The travelling grate is selected for efficient combustion system and to avoid heating of grates. The Ash is collected by the continuous movement of the travelling grate.

The air will be supplied by primary Forced Draft ("FD") fans & secondary air fans. The air towards Bagasse and coal will be controlled by the fuel air control system in order to guarantee safe and optimum combustion. The air supplied from FD fan will be heated up in air pre-heater. The pressure in the furnace will be controlled by the Induced Draft ("ID") fans installed at outlet of boiler. These fans will be provided with Variable Frequency Drive ("VFD") in order to optimize the power consumption. ID fans will discharge flue gases.

After complete combustion in furnace the flue gases shall enter the super heater section installed in the upper portion of the furnace. From the super heaters, the flue gases will flow downwards into modular bank. The evaporator section of the boiler will be designed for a large circulation ratio. Even during quick plant load changes the water circulation will be stable and thus prevent steam blockage in the evaporator sections.

From evaporator section, the flue gas shall enter the bare tube economizer from the top and leave at the bottom to Air Flue Gas Preheater. The economizer tubes will be supported in the structure of the economizer casing and will be bottom supported. The economizer will be fully drainable.

Thereafter, the Fly Ash Arrestor installed at the outlet of the Air Preheater. From Fly Ash Arrestor, most of the fly ash will be separated from the flue gases.

The condensate from the sugar mill shall be directly fed into the condensate tank from where it will be pumped to the deaerator via sugar plant exhaust condensate pumps through a level control system.

Demineralized ("DM") water will be supplied to the boiler for makeup. The makeup water will be pumped to the overhead surge tank via DM water distribution pumps. The makeup water will be added in the condenser hot well from the overhead surge tank by gravity through a level control system. The condensate from the condenser and makeup water added to the condenser hot well will be pumped to the deaerator by condensate extraction pumps.

3x50% Boiler Feed Water ("BFW") pumps shall be provided. BFW pumps are multistage, centrifugal type with low voltage 415V drive motors with VFDs. The condensate and make-up water lines will have level control valve to control deaerator level.

The control philosophy, boilers interlock and protection logic shall be implemented in Distributed Control System ("DCS") for safe operation of boiler.

2.2 Steam Turbine and Auxiliaries

2.2.1 Steam Turbine

The turbine of the cogeneration power plant will be multistage nozzle governed, horizontal spindle, two bearings, and extraction cum condensing type with 2 number of uncontrolled extractions and 1 number of control extractions. The exhaust from the turbine will be condensed in the surface condenser at 0.1 bar (a) pressure during off-season operation.
The low-pressure steam at 2.5 bar (a), 130^0C will be supplied to the sugar plant for juice heating in the evaporator station. The medium pressure steam at 5 bar (a), 155^0C will supplied for centrifugal washing. 95% condensate of the supplied LP steam will be returned from the sugar mill. There will be no condensate return of medium pressures steam.

2.2.2 Gear Box

Heavy duty reduction gear box of Double helical type with hardened & ground gears will be installed, capable of transmitting maximum power generated by turbine and able to withstand 20% over speed over a period of minimum 5 minutes.

The gear box will be designed with a service factor of 1.3 as per AGMA requirements.

2.2.3 Couplings

High speed coupling between the turbine & the gear box will be non-lubricating, steel laminated, flexible type. The coupling between the gear box and the alternator will be low speed. Both the couplings will have coupling guards and acoustic covers. Power rating of the couplings shall be in accordance with AGMA 514

2.2.4 Condensing System

Condensing system shall comprise of the following:

- Shell & Tube horizontal type surface condenser with integral hot well, thermal relief valve and atmospheric relief valve.
- Steam Ejector system consisting of:
    - Twin stage main ejectors (1 working + 1 standby) with two surface type inter and

after condensers.

- Startup hogging type ejector with silencer.

- Vertical canister type Condensate extraction pumps (CEPs), with a 3 x 50% capacity with LT motors and suction valves.
- Rupture disc for condenser protection.
- Expansion bellow with spool piece between turbine exhaust and condenser inlet
- Dry air/vapor line within specified battery limit

2.3 AC Generator

AC Generator shall comprise of the following:

- Brush-less exciter with PMG
- Air coolers
- Twin bearings
- AVR cum Excitation panel
- Anti-condensation heaters
- Water leakage detector- 1 per cooler
- Lube oil flow regulator - 1 per bearing

Generator electrical output rating shall be as follow:

- 33.125 MVA rated capacity at [50]° C ambient.
- [11] ± [10]% KV
- [50] ± [5]% Hz
- 3 Phase
- Power factor ([0.8] lag to [0.95] lead)
- ± [0.5]% Accuracy Control for Excitation system

2.3.1 Generator Protection and Control System:

Generation protection and control system will consist of the following equipment:

- Generator protection (Relay) Panel
- Metering & Synchronizing Panel
- MCC Panel
- Lightning arrestor, Surge capacitor and Potential transformer (LA, SC & PT) Panel
- Neutral grounding resistor (NGR) Panel
- DC Distribution

2.4 Governing System

The governor system provided will control the acceleration of the turbo generator and prevent over

speed without tripping the unit under any operating condition or in the event of maximum load rejection.

The governor system will have the following important functions:

- Speed control
- Over speed control
- Load control
- Inlet steam pressure control
- Extraction pressure control

2.5 Lubrication and Control System

A single forced feed lubrication system will be installed for Turbine, Gearbox & Alternator comprising of the following major components:

- Lube oil tank
- Oil Vapor extractor
- AC Electric Main Oil Pump (MOP) driven by gearbox low speed shaft
- AC electric Motor driven Auxiliary Oil Pump (AOP)
- DC Motor driven Emergency lube Oil Pump (EOP) with auto cut-in & cut-out facility
- Lube oil coolers (1working + 1 standby)
- Lube oil filters (1working + 1 standby)
- AC motor driven oil mist separator mounted on oil tank

2.6 Control Oil System

Control oil system will comprise of the following:

- AC electric Motor driven Auxiliary Control Oil Pump (ACOP) (1 working + 1 standby) to supply oil to Control system.
- Control Oil filter (COF) (1 working + 1 standby)

2.7 Main Cooling Water Pumps

The cooling water system shall be designed to provide cooling water to the following area of the plant:

- Surface Condenser
- Auxiliary cooling water coolers

The cooling water system includes the following major components:

2.7.1 Main Cooling Water Pumps

Three (3) Main Cooling Water Pumps (two working and one standby) each of capacity approximately 2600 m^3/hr shall be provided. Pumps will be horizontal centrifugal type, driven by

electric motors.

2.7.2 Auxiliary Cooling Water Pumps

Two (2) Auxiliary Cooling Water Pump (One working and one standby) will be provided. Pumps will be horizontal centrifugal type driven by electric motors.

2.7.3 Cooling Tower System

The Cooling Tower System shall have the following specifications:

- One (1) R.C.C structure mechanically induced draft, counter flow type cooling tower
- Capacity of cooling tower will be approximately 6600 m^3/hr and is combined and common for the whole cogeneration power plant.
- There shall be 2 cells each having a capacity of approximately 3300 m^3/hr.
- The cooling tower will be designed for a cooling range of 10°C, and an approach of 4°C while operating under the atmospheric wet bulb temperature of about 30°C.
- Each cell of cooling tower gear box will be equipped with vibration switches, oil temperature and oil level controls.
- The source of cooling water will be Bore Well Water.
- Cooling water supply and return temperature is 34°C and 44°C respectively.

2.8 Raw Water System

Raw water system consists off the following components:

2.8.1 Cooling Water Makeup Pump

Two (2) Cooling Tower make up Water Pumps for season and off-season operation will be provided.

2.8.2 Raw Water Transfer Pumps

Two (2) Raw Water Transfer Pumps (one working and one standby) each of capacity 20 m^3/hr will be provided to ensure raw water supply to Water Treatment Plant.

2.9 Compressed Air System

The function of this system is to provide service and instrument air for cogeneration plant operations. Compressed air system provides air to following users:

- **Instrument Air Users**: Instrument air will be required for the operation of pneumatic instruments like I/P converters, purge instruments, pneumatic actuation of control valves, dampers etc.
- **Service Air Users**: Service air will be required for cleaning of filters, strainers and general purpose.

2.10 Bagasse Handling System

The bagasse handling system comprising of chain conveyors & belt conveyors to transport the required quantity of bagasse from sugar mill to cogeneration shall be provided. Bagasse from the

sugar mill shall be fed to the boiler from a front mounted chain conveyor. Excess bagasse shall be returned to the bagasse storage yard. During off-season/non-availability of bagasse from mill, the cogeneration boiler shall use saved bagasse from the storage yard.

2.11 Ash Handling System

The ash handling system envisaged for the cogeneration boiler shall consist of Submerged Ash Belt Conveyor System and Dense Phase Ash Handling System.

2.11.1 Submerged Ash Belt Handling System

Submerged Ash Belt Handling System consists of conveyor belts, drive assembly, all type of pulleys, all type of idlers, bearing assembly, inlet / outlet chutes, take-up assembly, trough assembly, support frames, cross over, walkway, structural safety switches, water inlet / outlet / drain nozzles etc. The bottom ash at the discharge of travelling grate shall be conveyed by submerged ash conveyor system.

The ash shall be quenched in the water trough of submerged ash conveyor before conveying. The submerged ash conveyor shall discharge the ash directly to a trolley mounted tractor for further disposal.

2.11.2 Dense Phase Ash Handling System

This system will handle fly ash from boiler ash hopper (other than traveling grate & plenum ash hopper) and ESP hoppers. Surge hopper (water cooled for boiler ash hopper and non-water cooled for ESP hopper) arrangement shall be provided below the boiler and ESP hopper. Two air compressors with built in PLC control system and 1x100% air receiver shall be provided near the dense phase equipment. The required conveying air for dense phase ash system will be supplied by these compressors through air receivers. The ash silo storage capacity shall be enough to store 12-hours ash generation from both the boiler and ESP system.

2.12 Water Treatment System

The Cogeneration power plant make up water requirements will be met from the bore wells located in the sugar plant. For the make up for the cycle, it is proposed to take the raw water through a Water Treatment Plant with the following treatment scheme.

2 x Multi-grade Filter → 2 x Two Stage Reverse Osmosis system → 2 x Electro De Ionization system.(2x MGF + 2xRO +2x EDI)There shall be two independent streams. The capacity of water treatment plant is 30 m^3/hr. DM water is collected in two DM water tanks each having a capacity of 200 m^3. Water will be distributed from DM tanks through pumps to different users i.e. Deaerator, Condenser etc.

2.13 Firefighting System

The function of fire-fighting system is to supply water to the main risk areas of the cogeneration power plant.

The fire protection system is required for early detection, containment and suppression of fires. A comprehensive fire protection system shall be provided to meet the above objective and all

statutory and insurance requirements of National Fire Protection Association ("NFPA").

The fire-fighting system shall consist of the following:

2.13.1 Stand Pipe and Hose System:

Stand pipe and hose system shall be provided to cover the building and structures of the cogeneration plant. The system shall be designed as per the NFPA 14.

Standpipe shall have a hose of 65mm diameter with connection to a large supply of water. The hose connection shall be not less than 0.9m or more than 1.5m above the floor.

2.13.2 Fire Hydrant and Water Monitoring System

The hydrant system shall be provided to cover all areas. The system shall be designed as per NFPA 24. The system shall consist of over ground hydrant mains laid in rings, isolation valves, and stand pipes with hydrant valves (outdoor). A Hydrant shall be placed after every 40m.

2.13.3 Portable Fire Extinguishers:

Dry Chemical Powder, CO^2 and foam type extinguisher system shall be provided. The equipment shall be designed as per NFPA 10.

2.13.4 Automatic High Velocity Water Spray Nozzle System:

Automatic High Velocity Water Spray Nozzle System shall be provided along with deluge valve assembly for outdoor transformers in switchyard, generator & Turbine lube oil system area. The system shall be designed as per NFPA 15. The deluge valve assembly shall be UL/FM listed.

2.13.5 Fire Alarm & Detection System

Fire detection system for the power plant will provide early detection of fire and raise alarm. A comprehensive fire protection system shall be planned to meet the above objective and meet all statutory and insurance requirements of NFPA. A multitude of systems will be provided to combat various types of fires in different areas of the plant and all such systems for various areas shall form a part of a centralized protection system for the entire plant. Fire alarm system detection system shall be provided in following areas:

- Firm alarm and signaling in all electrical/instrumentation panel rooms in TG building
- Manual call points and Electric Horns in outdoor areas.

2.14 Effluent Handling System

Effluent handling system consists of the following main components:

2.14.1 Neutralizing Pit

Acid/caustic produced (if any) from Water Treatment Plant will be collected in neutralization pit. This effluent will be transferred to effluent pit after neutralization.

2.14.2 Neutralized Effluent Re-circulation cum Transfer Pumps

Two (2) Neutralized Effluent Re-circulation cum Transfer Pumps (One working & one standby) shall be installed at Neutralization pit to transfer effluents from Neutralization pit to Effluent pit in water treatment plant area.

2.14.3 Effluent Pit

Effluents like Boiler blow down, cooling tower blow down, RO reject, MGF backwash, side stream filter flushing, RO flushing, neutralized effluent from neutralization pit, etc. shall be collected in the separate effluent pit near Water Treatment Plant area.

2.14.4 Effluent Transfer Pump

Two (2) Effluent Transfer Pumps (One working and one standby) will be installed on Effluent pit to transfer effluents. The pumps will also be used to re-circulate the effluent with in Neutralization pit for effective neutralization. The pump capacity shall be minimum 200 m^3/hr.

2.15 Service Water System

Two (2) service water pumps (One working and one standby) will be installed to provide service water to plant users. One (1) expansion vessel will be installed to keep service water header pressurized.

2.16 Electric Overhead Travelling (EOT) Cranes

EOT cranes shall be provided in the following buildings:

TG Hall

An Electrically operated EOT crane shall be provided for the erection and maintenance requirements of turbo generator and its auxiliaries.

The main hook capacity shall be 70 Tons and suitable for lifting single heaviest component in Turbo Generator. The auxiliary hook lifting capacity shall be of 5 Tons. The crane travel will cover the entire length of the TG building. The crane shall be electrically operated, bridge type and shall be designed and equipped for indoor operations complete with all accessories. The crane bridge shall consist of bridge girders each carrying a rail on which a wheeled trolley is to run. Operation of crane shall be by pendant type push button station from ground level.

Workshop and Store

An Electrically operated EOT crane shall also be provided for routine maintenance activities and store material handling to be carried out in the building.

The single hook crane capacity shall be 5 Tons. The crane travel will cover the entire length of maintenance bay of workshop. Operation of crane shall be by pendant type push button station from ground level.

3 Electrical Design

3.1 Electrical Network

The Plant shall consist of one generator and associated auxiliaries for smooth plant operation. A synchronous alternator for the proposed co-generation power plant with generation at 11 kV will be connected to a 132kV system through 11kV switchboard and step-up Power Transformers.

The connection between generator and 11kV switchboard shall be through phase segregated Phase Bus Duct and between 11kV switchboard and 11/132kV power transformer shall be through 11kV HT XLPE cables.

The generator will operate in parallel with NTDC National grid. A portion of the power generated in the turbo-generator will meet the power requirements of the Cogeneration plant auxiliary loads and the sugar plant loads through step down transformers.

The surplus power, after meeting the power requirement of cogeneration plant auxiliaries and sugar plant auxiliaries, shall be exported to the grid through 11/132kV power transformer. There shall be total of 2 step-up power transformers (one working + one standby) to meet N-1 condition of NTDC.

Entire power evacuation system and associated equipment shall be designed so as to export the entire power from cogeneration plant (total generation less auxiliary power consumption), when the sugar plant is not in operation.

All the existing sugar plant loads shall be fed through one (1) 12.5MVA 11/3.3kV interconnecting transformer for existing loads and proposed 11kV sugar switchboard for mill house loads.. Power for the 11kV sugar switchboard shall be fed from 11kV cogen switchboard which shall be interconnected through HT cables.

3.1.1 Ambient Conditions for Electrical Equipment

Ambient conditions and design temperatures for electrical equipment are given in Table 6 below:

Table 6: Ambient Conditions for Electrical Equipment

	Deg C
Maximum Temperature	[50]
Indoor Equipment Design	[50]
Outdoor Equipment Design	[50]

3.2 Plant Operating Voltage

The plant shall be designed suitable for operating at a frequency of 50Hz, with voltage levels of various systems of the plant as given in Table 7 below:

Table 7: Plant Operating Voltage

Generation (TG) system	[11] kV
Power evacuation system	[132] kV

Non-AC VSD / auxiliaries of cogeneration plant	[415] V
AC VSD / auxiliaries of co-generation plant	[415] V
DC system of co-generation plant	[110] V
UPS system of co-generation plant	[230] V

3.3 Basic Electrical Design Parameters

Basic electrical design parameters for the Plant are given in the table below:

Table 8: Basic Electrical Design Parameters

Power Factor (lagging)	[0.8]
Generation Voltage (kV)	[11] kV, 3 phase
Parallel operation with Grid	Required with [132]kV grid
Grid Voltage	[132] kV, 3 phase
System Frequency	[50] ± [5]%
System Voltage Variation	±[10]% Variation of Rated Voltage
System Fault Level	
132 kV	[40] kA
11 kV	[40] kA
415 V	[50] kA
Fault Level & Withstand Duration	
132kV Switchgear	[40] kA for [1] sec
For 11 kV Switchgear	[40] kA for [3] sec
For 415 V Switchgear	[50] kA for [1] sec
400V Lighting System	[10] kA for [1] sec
11kV Segregated Phase Bus Ducts	[40] kA for [3] sec
110VDC	[25] kA for [1] sec
48VDC	[10] kA for [1] sec
230VAC	[10] kA for [1] sec
Transformer and all accessories	All transformers and its accessories shall be capable of withstanding for [3] seconds short circuit at the terminal
Earthing System	
132 kV	Effectively earthed
11 kV	Neutral grounded (limited to < 50 A) / Unearthed (Whenever the generator is not in service)
415 V	Effectively earthed
110 V DC	Unearthed

3.4 132kV Switchyard

Switchyard shall be supplied for interface with NTDC Grid in line with following specifications and NTDC requirements. Detailed specifications of the switchyard are given in the table below:

Table 9: 132kV Switchyard Specifications

Voltage Level	[132] kV
Service	Outdoor AIS with SF6 circuit breakers
Number of Bays	[2] OHL Bays [2] Transformer Bays [1] Bus-Coupler Bay
Bus Bar	AAC conductor of "Hawthorn"
Short Circuit SF6, gang operated	[3150] Amp [40]kA [1] sec
Isolator (Centre break, motor operated with copper alloy blades)	[2000] Amp
Protection & Metering	As per NTDC Requirements
Highest System Voltage(kV rms)	[145] kV
Power frequency withstand capability (kV rms)	[275] kV
Basic insulation level (kV peak)	[650] kV
Creepage distance for insulators (mm/kV)	[25]
Instrument Transformers	Hermetically sealed, dead tank design. Rating as per SLD
Insulator	Brown glazed with min 6kN cantilever Strength
Towers & Support Structures	MS galvanized lattice type
Tariff Metering equipment	Three elements four-wire configuration, electronic, digital, with accuracy class of 0.2S; 30 minutes intervals for a period of 70 days with intervals programmable from 5 minutes to 30 minutes

3.5 Steam Generator

Generator shall be supplied in line with the following specifications:

Table 10: Steam Generator Specifications

Description	Parameters
Rating & Count	26.5 MW
Type	Synchronous type
Number of pole & Excitation System	Four pole, with brushless excitation system.
Power Factor	[0.8]PF (lagging) to [0.95] (leading) under entire band of ±[10]% voltage variation and ±[5]% frequency variation
Insulation Class	Class 'F' insulation and shall be suitable for operation within class 'B' limits
Overload Requirements	Over loading of 110% for one hour every 12 hours and 150% for 30 seconds
Short Circuit and Overload Endurance	Generator shall withstand short-circuit of any kind at its terminal, while operating at rated load and 105% rated voltage for at least 3 seconds

3.6 Segregated Phase Bus Duct

Generator shall be connected to 11kV panel through Segregated Phase Bus Duct with Copper conductors. All other electrical distribution connections shall be through MV or LV rated cables as per application and voltage grade. Technical details of the Segregated Phase Bus Duct are given in the table below:

Table 11: Segregated Phase Bus Duct Specifications

Application	Steam Generator Connection to 11kV Panel
Power Frequency Withstand Voltage	28kV
BIL	75kVp
Enclosure	Minimum thickness of 3mm
Sizing Basis	Maximum through fault current either from 132kV grid or from the generator including contribution from total plant loads through Auxiliary Transformers with 20% margin on higher side or 50kA, whichever is higher

3.7 11kV Switchboard

11 kV switchgear shall be of indoor, metal clad, fully draw out truck type with vacuum circuit breaker. The switchgear shall be suitable for maximum system voltage of 12 kV. The power frequency voltage of the board shall be 28kV and BIL of the panel shall be 75kV (peak). The circuit breakers and switchgear assembly shall withstand the rated short circuit current for not less than three seconds. The breakers shall also be rated for peak asymmetrical current with a rating of 2.5 times symmetrical rated current. The switchboard shall have incomer, Tie, Bus coupler and outgoing feeders of rating 3150A / 2000A / 1250A for distribution of power to cogen and sugar plant and power export.

3.8 3.3kV Panel

One (1) 3150A 3.3kV VCB stand-alone panel shall be provided for feeding power to existing sugar plant loads through 12.5MVA 11/3.3kV Interconnection transformer, which shall be provided in between the 11kV sugar switchboard and 3.3kV stand alone panel.

3.9 415 V Switchboard

All the cogeneration plant auxiliary loads shall be segregated into AC Variable Speed Drive (AC VSD) driven loads and non-AC VSD driven loads.

All AC VSD loads pertaining to cogeneration plant shall be connected to one (1) of 11/0.415/0.415kV AC VSD transformer and non-VSD loads shall be connected to one (1) of 11/0.415kV AC VSD transformer. Both the VSD and non-VSD switchboards shall be interconnected through tie ACB feeders. DG incomer shall be provided in the non – VSD switchboard to meet the plant startup / emergency loads. These switchboards shall be designed for 50 kA for 1 sec. The busbar material of the panel shall be of copper.

3.10 Transformers

Technical specifications of the different transformers to be installed in the Project are given in the table below:

Table 12: Specifications of Transformers

Description	Parameters
Generator transformer (GT) / Power Transformer	[28/35] MVA [132/11] kV YNd11
VSD transformers [Three winding transformer] for co-generation plant	3.15 MVA 11/0.415/0.415 kV, Dyn11Dzn0
Interconnection transformer at sugar plant	12.5MVA, 11/3.3kV, Dyn11
Lighting Transformer	150kVA, 415V/400V, 50Hz, Dyn11, dry type, Three Phase, Two Windings
Neutral Grounding Transformer	Zn0 windings, 50A for 10Sec & 500A for 3Sec, 11KV, ONAN

3.11 AC & DC UPS System

AC and DC UPS system will be supplied for loads that require un-interrupted power. Following UPS shall be supplied for this purpose:

Table 13: AC & DC UPS Specifications

Description	Parameters
110VDC for TG system	1x100% Dual FCBC with Battery Bank [VRLA Type]
110VDC for Switchyard	2 sets of Battery banks SMF type 2V Cell batteries, suitable for 110V DC system along with FCBC.
230VAC UPS	2x100% Dual Redundant UPS with Dedicated Battery Bank [SMF type: Sealed Maintenance Free]
230VAC Emergency Lighting inverter	Minimum 16kVA inverter with battery backup

3.12 Control Philosophy & Interfacing

Critical and important electrical loads shall be interfaced with SCADA system [built in plant DCS] for local and remote operation in-line with plant operational & safety requirements.

3.13 Energy Management System

The incoming and outgoing feeders of 132kV Switchyard Bays, Main MV [PCC] Panel and AC-VSD panel outgoing feeders shall be provided with PQM/TVM with communication port suitable for MODBUS-RTU protocol. One daisy chained link shall be provided for each switchboard which

will communicate soft data to Plant DCS. All these meters shall be hooked up to a dedicated Energy Management System for data logging built in plant DCS.

Communication ports of MODBUS - RTU shall be planned in all TVMs and PQMs provided in the PCCs, AC VSD panels and control panels of the TG, Generator Transformer and switchyard control and relay panels. All the ports shall be hooked up to Energy Management System (Part of DCS) for data logging as well as monitoring purposes. The mimic representation of the complete electrical distribution shall be provided in Energy Management System (part of DCS) from 132 kV level to major/main LT panels.

3.14 RTDs & Thermistors

Thermistors shall be installed on motors rated between [30] to [75] kW. RTD shall be made available for motors rated from [90] kW and above. All RTDs shall be hooked up with relays in Motor Relays in respective MCC.

3.15 System Earthing

The grounding installation work shall be as per recommendation of IEEE-80. All panels, transformer, LAVT, NGR and motors shall be provided with double earthing. Lightning protection for tall structure shall be in line with IEC standards.

132kV system shall be solidly grounded through 132 kV side of transformer neutrals at NTDC side as well as neutral of generator transformer on 132 kV side at co-generation plant.

TG system shall be grounded through Neutral Grounding Resistor ("NGR") panel to limit the earth fault current to [50] A to suit the system requirement, through the [11] kV neutral point of TG. The [11] kV system shall be provided with 11 kV Earthing Transformer and Neutral Grounding Resistor (NGR) panel to limit the earth fault current to 50A. This NGR of earthing transformer shall be switched ON whenever the power is imported from the grid with TG circuit breaker in open condition. The [3.3] kV system at the secondary side of Interconnection Transformer shall be provided with NGR grounding to limit earth fault current of [100] A.

LV system 415V system shall be solidly grounded through transformer neutral. Neutral busbars shall be made available in 415V PCCs, and all MCCs.

415V VSD transformer grounding system shall be as for 6 Pulse AC VSD drives – Solidly grounded.

400V system used for illumination system and small power distribution system shall be solidly grounded.

UPS System shall be of insulated neutral type (ungrounded). DC System shall be of ungrounded type.

3.16 Cable Installation

Cables shall be installed in concrete cable trenches [installed on trays], on cable racks and direct buried as required. All outdoor cables shall be laid on over head cable trays. No cables shall be

buried, except for outdoor lighting cables. Outdoor cable racks shall have clearance of minimum 6 M between the ground level and the lowest point of the cable racks.

3.17 Cable Trench

Concrete cable trenches shall be fitted with ventilation fans, air inlets, normal lighting, emergency lighting, utility sockets, fire alarm detectors, manual call points, and annunciation sirens. All wiring shall be in GI conduits.

Trench shall have access inlets provided with ladders, slopped on two sides having water excavation pits and two pumps.

3.18 Lighting & Small Power

Plant lighting loads shall be fed through One (1) No. of 415/400V, Dyn11 connected dry type lighting transformer of minimum rating of [150] kVA.

Emergency Lighting Distribution Board ("ELDB") shall be fed through inverter of minimum [16] kVA rating.

The number of sockets [where maintenance & operation is required] shall be provided in the indoor area in such a way that approachable distance of any socket is not more than 10M distance. Minimum four (4) nos. of 24V lighting kit shall be provided for the plant.

63A power and welding socket shall be provided in all indoor as well as outdoor area wherever maintenance of mechanical equipment is required. Each socket shall comprise of MCB with ELCB and power / welding socket.

3.19 Plant Communication System

Plant communication shall be provided with following facility:

- Telephone system
- Public Address System
- Walkie-talkies.

3.20 Enclosure Ratings

Enclosure IP ratings for different applications shall be as below:

Table 14: Enclosure Ratings

HV Switchgear	IP4X
LV Switchgears	IP4X
Switchgears located outdoors	IP55
Control Panels	IP42
Motors	IP55
Push Button Stations	IP54 (indoor) IP55 (outdoor)
Segregated Phase Bus ducts	IP54 (indoor)

	IP55 (outdoor)

3.21 Plant Startup

The co-generation plant shall be started with two (2) numbers of 415V Black start DG sets. These DG sets shall be connected to DG panel, which shall be planned with two incoming DG set feeder and two outgoing feeders.

Plant startup can also be managed either from Grid supply or Black start DG sets.

The DG set shall be with radiator cooled type. Proposed rating of each DG set shall be minimum 1500kVA at Prime duty

3.22 Instrumentation and Control ("I&C") Systems

I&C System will ensure control and monitoring of operations of both the technological and electrical part of Cogen Power Plant including balance of plant (auxiliary operations) and 132 kV switchyard. Control room and its auxiliary equipment will be located in an outbuilding ("CCR") adjacent to the Turbine Hall. I&C System will be designed as a complex system capable to control the whole Cogen unit both in standard conditions and transient operating conditions (start-up, shutdown, etc.). Specific autonomous functions of protections and control for steam turbines will be performed by their dedicated control system, nevertheless this dedicated control system will be an integral part of the whole I&C System from the viewpoint of operation, monitoring and control. I&C System will ensure control and monitoring of the following equipment:

- Boiler and its Auxiliaries
- Fuel Handling System
- Ash Handling System
- Steam turbine with accessories
- Balance of plant
- Electric equipment of Switchyard

3.23 Digital Control System ("DCS")

The controlling and monitoring of operation of main power unit, loading and synchronizing, balance of the plant will be provided from the common control room through the operator panels of the process, electrical part including power outlet equipment, frequency control and switchyard etc. The working place of the system operator will be placed at the control room. The working place of shift engineer will be located in a separate room with the window to the control room. The DCS will be based on fully redundant process and network bus. The power plant will be fully automated with a target of high operation reliability as well as high operation safety. Control system will fulfill required standard functions for securing optimal, economical, safe and ecological operation for installed equipment in nominal and transient operation conditions. System will cover control function from basic level control up to fully automated control of function groups and units, control of system output and optimization of block operation. Specific autonomous functions of the plant safety system and selected regulation and control functions will

be realized by special subsystems in a hierarchical model. From a viewpoint of control, these items will create an integrated part of the DCS control system.

Hardware and software will enable realization of loop control, binary control, data functions, monitoring, remote control and emergency manual control. Communication within the system will be handled by bus routing connected to the standard bus system RS 485, Ethernet etc.

Mehran Energy Limited

26.5 MW Bagasse-based Cogeneration Power Project
Deh Daro Sutha, Dist Tando Allahyar, Sindh

Feasibility Report

Table of Contents

1 Project Background

Mehran Sugar Mills Limited ("MSML"), through a wholly-owned subsidiary Mehran Energy Limited ("MEL"), intends to set up a green field 26.50 MW (Gross) high-pressure, bagasse based co-generation power plant (the "Project") under the provisions of the Framework for Power Cogeneration 2013 ("Framework") and Policy for Development of Renewable Energy for Power Generation 2006 ("RE Policy" or "Policy"). The Project will be located within the premises of MSML at Deh Daro Sutha, Tando Adam Road, Distt. Tando Allahyar, Sindh.

The Project will sell power to the national grid through sale of energy to the Central Power Purchasing Agency Guarantee Limited ("CPPA-G") under a 30-year Energy Purchase Agreement ("EPA"), as well as partially meet the steam and power requirements of MSML during the crushing season. The Project will enable MSML to establish a sustainable market for its by-product, bagasse, and will also allow the sponsors of MSML to take an exposure in the power sector through incentives offered by the Government of Pakistan ("GoP") under the Framework and RE Policy.

The objective of this financial feasibility report ("Feasibility") is to assist MSML in assessing the viability of the Project under a ***given set of assumptions.***

2 Power Market

2.1 Structure of Power Sector in Pakistan

Historically, the power sector in Pakistan has been owned and operated by government entities, primarily the Water and Power Development Authority ("WAPDA") until the drive to unbundle started in the early 1990s. Since then the sector has evolved much with private sector involvement primarily in generation and more recently on the model of a fully vertically integrated utility company. The generation, transmission, distribution and retail supply of electricity in Pakistan is presently undertaken by several public and private sector entities comprising of one (1) national transmission company; nine (9) regional public sector-owned distribution companies; four (4) public sector thermal generation companies; one (1) public sector hydropower generation company and several Independent Power Producers ("IPPs"). These entities enable the supply of power to the entire country except for Karachi. The metropolitan city of Karachi and some of its surrounding areas are supplied power by K-Electric, which is a vertically integrated utility owned by the private sector responsible for the generation, transmission and distribution of electricity in its region. The total installed capacity of the entire country in 2015 was 24,823 MW of which 16,814 MW (67.74%) was thermal, 7,116 (28.67%) was hydroelectric, 787 MW (3.17%) was nuclear and 106 MW (0.43%) was wind.

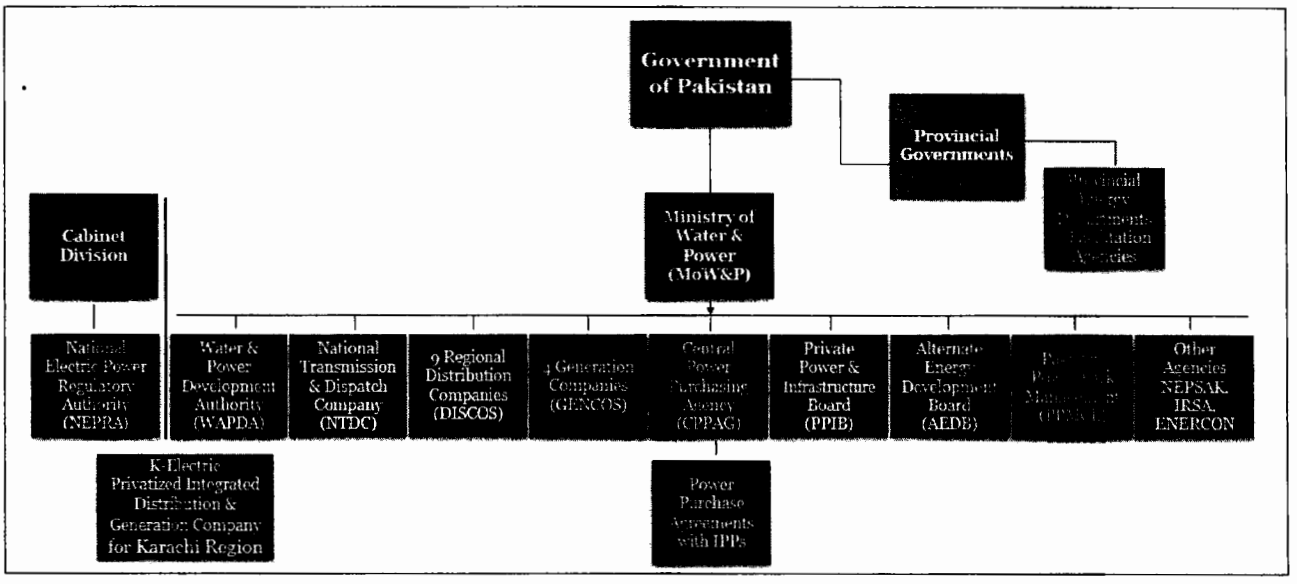
Table 1: Pakistan Power Generation Capacity

As on 30th June	2011	2012	2013	2014	2015
Thermal	15,910	15,969	15,941	15,719	16,814
Hydropower	6,645	6,730	6,947	7,116	7,116
Nuclear	787	787	787	787	787
Wind	0	1	50	106	106
Total	23,342	23,487	23,725	23,728	24,823

All figures in MW; Source: NEPRA State of Industry Report, 2015

More recently the CPPA, previously residing within NTDC, has been converted into a legal, independent body acting as a central counterparty to power purchase transactions. The present form of the power structure in Pakistan is presented below:

Table 1: Pakistan Power Sector Structure



2.2 Electricity Generation

Historically, Pakistan has relied on hydropower generation to meet its electricity demands, as the ratio of hydel to thermal installed generation capacity in the country in 1985 was about 67% to 33%. However, with the passage of time, the energy mix has shifted towards thermal power generation, which now generates approximately 65% of total power produced in the country. Electrical energy generated in recent years by fuel type is presented in the table below:

Table 2: Pakistan Energy Generation by Source

As on 30th June	2010-11	2011-12	2012-13	2013-14	2013-14
Thermal	65,169	64,478	64,034	68,082	69,988
% Share	*64.79*	*65.94*	*64.91*	*64.41*	*64.17*
Hydel	31,990	28,643	30,033	32,239	32,979
% Share	*31.80*	*28.85*	*30.44*	*30.50*	*30.24*
Nuclear	3,130	4,872	4,181	4,695	5,349
% Share	*3.11*	*4.91*	*4.24*	*4.44*	*4.90*
Import	295	296	375	419	443
% Share	*0.29*	*0.30*	*0.38*	*0.40*	*0.41*
Wind	0	6	32	263	300
% Share	*0.00*	*0.01*	*0.03*	*0.25*	*0.27*
Total	100,584	99,295	98,655	105,698	109,059

All figures in GWh; Source: NEPRA State of Industry Report, 2015

Given the acute gas shortage in the country, thermal generation has relied mostly on expensive fuels such as Furnace Oil and High Speed Diesel. Increased dependence on expensive thermal fuel

sources has not only led to high cost of generation but has also resulted in large amounts of foreign reserves to be spent on the import of fuel. Thermal generation breakdown in the country in recent years is given in the table below:

Table 3: Pakistan Energy Generation by Source (Thermal Fuel Mix)

	2010-11	2011-12	2012-13	2013-14	2014-15
Gas	37,076	30,162	28,190	30,769	31,196
% share of thermal generation	*56.89*	*46.06*	*44.02*	*45.19*	*44.57*
FO + HSD	27,984	35,250	35,804	37,201	38,690
% share of thermal generation	*42.94*	*53.83*	*55.91*	*54.64*	*55.28*
Coal	109	66	40	112	102
% share of thermal generation	*0.17*	*0.10*	*0.06*	*0.16*	*0.15*
Total	65,169	65,478	64,034	68,082	69,988

All figures in GWh; Source: PSS/NTDC/KEL

Due to this skewed energy mix, it has now become imperative upon the power sector in Pakistan to move towards generation technologies that are sustainable and rely on indigenous resources.

2.3 Demand and Supply of Electricity

For the past decade or so, Pakistan has been suffering from an acute energy crisis due to rising demand exacerbated by structural flaws within the sector. Some of the major reasons contributing to this crisis include:

1. Inefficient transmission and distribution
2. Increasing demand
3. Inefficient use of energy
4. Expensive energy mix and
5. Improper pricing.

Installed capacity in the country grew at an average rate of 5.51% during the period 1990-2015. However, this increase in capacity has been unable to meet the demand of electricity leading to a demand-supply gap, which can go as high as 6,600 MW during peak hours. In 2015, the maximum generation capability remained at 19,132 MW, while the maximum peak demand reached 24,757 MW, resulting in a 5,625 MW gap between supply and demand. Projections by government agencies depict that this shortfall is not going to end till 2018. The tables below show the actual and projected surplus/deficit in demand during system peak hours:

Table 4: Pakistan Historical Supply and Demand of Power

Year	Generation Capacity	Peak Demand	Surplus/(Deficit)
2011	15,430	21,086	-5,656
2012	14,483	21,536	-7,053
2013	16,846	21,605	-4,759
2014	18,771	23,505	-4,734
2015	19,132	24,757	-5,625

All figures in MW; Source: NTDC

Table 5: Pakistan Projected Supply and Demand of Power

Year	Planned Generation	Projected Peak Demand	Surplus (Deficit)
2016	20,303	25,666	-5,363
2017	23,445	27,185	-3,740
2018	28,751	28,678	73
2019	33,545	30,154	3,391
2020	35,590	31,625	3,965

Source: NTDC

Shortage of electricity has become the most critical challenge by not only causing social disruption, but also affecting the economic growth of the country. According to estimates, energy shortages in the country have resulted in approximately 2% reduction in the annual GDP of the country. Therefore, resolving the energy crisis is amongst the top priorities of the government and steps are being taken to attract new investment in the power sector. Moreover, steps are being taken to optimize the generation mix by adding renewable and indigenous energy sources.

2.4 Key Organizations

2.4.1 National Electric Power Regulatory Authority ("NEPRA")

In order to promote fair competition in the industry and to protect the rights of consumers as well as producers/sellers of electricity, the GOP enacted the Regulation of Generation, Transmission and Distribution of Electric Power Regulation Act, 1997 ("NEPRA Act"). Under this Act, the NEPRA Policy for Power Generation Projects was established for regulating electric power generation, transmission and distribution in Pakistan. In performing its functions under this Act, NEPRA is required to, as far as reasonably possible, protect the interests of consumers and companies providing electric power services in accordance with the guidelines laid down by the government. One of NEPRA's most prominent roles is tariff approval for the Project.

NEPRA's role in the power business, inter alia, is to issue licenses for companies and to regulate their operations per NEPRA rules and regulations. The prospective applicants will be required to comply with all NEPRA rules/procedures, inter alia, for grant of license before security agreements are concluded for any project.

2.4.2 Private Power and Infrastructure Board ("PPIB")

PPIB provides a one-window facility to IPPs for implementation of projects above 50 MW capacity and issues the Letter of Interest ("**LOI**") and Letter of Support ("**LOS**"), prepares pre-qualification and bid documents, pre-qualifies the sponsors, evaluates the bids of pre-qualified sponsors, assists the sponsors/project companies in seeking necessary consents / permissions from various governmental agencies, carries out negotiations on the Implementation Agreement ("**IA**"), assists the power purchaser, fuel supplier, government authorities in the negotiations, execution and administration of the EPA, fuel supply agreement and water use license respectively, issues and administers the GOP guarantee backing up the power purchaser, fuel supplier and follows up on implementation and monitoring of projects.

2.4.3 Alternate Energy Development Board ("AEDB")

AEDB has been designated as one-window facility for processing all alternative and renewable energy projects in the private sector projects such as wind, biodiesel, bagasse/biomass/waste to energy, small/mini/micro hydro and solar power projects. AEDB also issues bankable IA, EPA, LOI and LOS to alternative energy producers. AEDB shall be the relevant GoP facilitation agency for the issuance of the LOI and LOS as well negotiation of the IA and provision of the GoP guarantee as applicable for the Project.

2.4.4 Central Power Purchasing Authority Guarantee Limited ("CPPA-G")

CPPA-G, a company created by Government of Pakistan, is a non-profit independent company established under the Companies Ordinance, 1984 and solely responsible for implementing and administering the "Single Buyer Plus" market mechanism (ultimately leading to competitive market operations). CPPA-G purchases power on behalf of Distribution Companies ("**DISCOS**") from IPPs. The Project shall be entering into negotiations with CPPA-G for the sale of energy to the national grid and shall enter into an EPA in this regard.

2.4.5 Hyderabad Electric Supply Company ("HESCO")

HESCO was formed to take over/acquire all the properties, assets and liabilities of Hyderabad Area Electricity Board owned by WAPDA. The company was incorporated on 23rd April 1998 and certificate for commencement of business was obtained on 1st July 1998 from NEPRA. HESCO serves 975,346 consumers and has administratively divided 12 districts of Sindh Province into 4 operation Circles: Hyderabad, Laar, Nawabshah and Mirpurkhas.

3 Applicable Framework & Policy

The Project is being set up under the Framework for Power Cogeneration 2013 pursuant to the Policy for Development of Renewable Energy for Power Generation 2006 being administered by the AEDB. Under the terms of the Framework and Policy, electricity purchase by the CPPA-G from bagasse-based projects has been made mandatory.

The conditions of the Framework/Policy envisage MSML/MEL seeking an LOI from AEDB for the Project (which the company has already been issued). In May 2013, NEPRA announced an upfront tariff (**"Upfront Tariff"**) for high-pressure boiler based bagasse projects being set up under the Framework. The Upfront Tariff has subsequently been extended up to May 2017; the Company shall upon completion of the applicable pre-requisites apply to NEPRA for the same.

Upon receipt of the Upfront Tariff approval from NEPRA the Project Company shall seek an LOS from AEDB; following which the Company shall enter into negotiations of the EPA and IA with CPPA-G and AEDB respectively, which shall be followed by the financial close of the Project. Under the terms of the Upfront Tariff (and LOS) the Company is required to achieve the commercial operations date of the Project within 24 months from date of approval of the Upfront Tariff for the Company.

In parallel, the Company shall also apply to NEPRA for the issuance of the generation license for the Project. The application for the generation license shall be made following the issuance of the LOI and will be issued, amongst others, after submission of an approved grid interconnection study from HESCO and an environmental study from the relevant authority.

4 Cogeneration

4.1 Bagasse Based Cogeneration

Cogeneration refers to generation of electricity and useful heat from use of a single fuel at high efficiency. Cogeneration is a well-known process in sugar industry as every sugar mill requires steam for sugar manufacturing while supply of electricity is also necessary to operate machinery. The steam provides thermal energy which is used in heating and concentrating the juice into syrup. This process of juice concentration to syrup involves the evaporation of water in the juice by using low pressure steam as the heating medium. With the large quantum of low pressure steam usage, the sugar industry stands as an ideal candidate for cogeneration. Historically, most sugar mill boilers and the power houses were designed primarily to meet the process steam and electricity requirements of the sugar mill. Therefore, the boilers and turbo-generators employed are mostly of low pressure and low temperature style.

There has been, of late, increasing awareness of the advantages of installation of high pressure, high efficiency bagasse based systems. With installation of high pressure boilers, electricity over and above internal use can also be produced and sold to national grid, if allowed. Exports of electricity can make cogeneration an attractive and cost-efficient means of cutting production costs, reducing pollution and generating additional revenues depending on the ratio between the price of electricity secured and production cost of electricity generated in the sugar industry.

5 The Project

The 26.50 MW Co-generation Project envisages a 1+1 configuration power plant comprising of a high pressure (110 bar) traveling grate boiler having a steam capacity 135 tons per hour, a 26.50 MW condensing/extraction steam turbine generators and balance of plant **("Plant").** It is planned that, **during the crushing period,** steam and power for MSML operations will be provided from the existing Low Pressure **("LP")** system and the balance steam/power requirement of MSML will be met through the High Pressure **("HP")** system of the Plant. During the crushing period, bagasse from MSML will be utilized both in the HP and LP Systems to generate steam and power. (Note: Only power generated from the HP system may be sold to CPPA-G). During the non-crushing period only the HP system shall operate, which will use un-utilized bagasse available with MSML as fuel. Detailed workings regarding the fuel availability and generation mix are provided in the following sections.

5.1 Project Site and Location

The Project Site will be located within the premises of MSML located at Deh Daro Sutha, Tando Adam Road, Distt. Tando Allahyar, Sindh. The total area of the sugar mill and its premises is 136.34 acres and of that, approximately 20 acres will be allocated to the construction of the power plant.

A map of the Project site is given below and a detailed plant layout has been attached as Annexure 1:

6 Plant Type and Technology

6.1 General Design

The design of the Facility is typical for a biomass-fired cogeneration facility which also is specific to the use of bagasse and to the cogeneration requirements.

The boilers will consist of tall water wall furnace with platen generators located at the top of the furnace. The super heater will have three stages. The first stage is a horizontal tube convective super heater located in the boiler second pass. The second stage consists of platens located at the top of the furnace adjacent to the generator section. The third stage consists of pendants located above the furnace arch between the second and first stages. Following the super heater will be three horizontal tube economizer sections and four tubular air heater sections.

The steam cycle consists of two high pressure feed water heaters and a deaerator for each unit. The high-pressure feed water heaters take steam from the two uncontrolled extractions of the steam turbine. Steam for the deaerator is to be supplied from the controlled extraction of the steam turbine.

The Facility has two modes of operation defined by steam needs of MSML. During the crushing season, MSML needs steam and electricity to crush the sugar cane and produce sugar. Steam for MSML will be supplied from the controlled extraction of the steam turbine which is at approximately 2.5 bar pressure. The expected steam demand for MSML is 88 tons/hr. The

electricity demand during the crushing season is 11.967 MW. During the off-season, the electricity demand is 0.5 MW.

6.2 Technology

Combustion technology based on the Rankine Cycle will be utilized in this project which is proven to be the latest technology. The bagasse will be combusted in a high-pressure boiler and the steam generated will be fed to the steam turbine to generate power. The turbine will be different from the conventional thermal power plants as the turbine will be provided with a controlled extraction for extracting the process steam required for the sugar mill. To enhance the efficiency of operation, regenerative heaters are used in the feed water circuit. For the cogeneration power plant proposed for MEL, the cogeneration cycle is based on the parameters of 110 bar(a) and 540 degree centigrade at the boiler outlet, currently being used in many countries for the cogeneration projects. The cycle chosen with the above parameters is the latest used in many of the bagasse fired installations around the world. These above selected parameters make the cycle more efficient and help in the generation of more units for the same quantum of the fuel.

There are already many Cogeneration plants operating in Pakistan & India with these parameters and the operating experience of those plants, in synchronization with the sugar mill operation, has been smooth and without any hitch. The Cogeneration scheme for MEL proposes 1x135 TPH capacity boilers and 1x26.5 MW extraction condensing turbo generators. Considering the offseason operation of the plant, the Cogeneration power plant boilers will be designed for firing the saved bagasse and a few other compatible bio-mass fuels.

7 Design and Specifications of the Plant

7.1 Bagasse Fired Boiler

The Boiler shall be single drum, natural circulation, radiant furnace with water cooled membrane wall, three stage super-heater with two stage attemperator, balanced draft and travelling grate bagasse fired boiler. The boiler is capable of a peak generation of 110% of the MCR for a period of half an hour in eight-hour shift. The boiler shall be top supported, outdoor type, with adequate provisions for the thermal expansion of the boilers in all directions.

Design Parameters:

- Bagasse Fired Boiler; 135 TPH
- Steam pressure at the Main Steam stop valve outlet: 110 bar(a)
- Steam temperature at the Main steam stop valve outlet at MCR: 540 ± 5 ^{0}C
- Boiler feed water temperature at the inlet to the Deareator: 210 ^{0}C.
- Maximum noise level at 1.0 m distance for the boiler: 85 dB(A)
- Maximum noise level at 1.0 m for boiler drum safety valves: 85 dB(A)

The Bagasse through drum feeders, screw feeders and pneumatic spreaders will be fed into the furnace. The travelling grate is selected for efficient combustion system and to avoid heating of grates. The Ash is collected by the continuous movement of the travelling grate.

The air will be supplied by primary Forced Draft ("FD") fans & secondary air fans. The air towards Bagasse and coal will be controlled by the fuel air control system in order to guarantee safe and optimum combustion. The air supplied from FD fan will be heated up in air pre-heater. The pressure in the furnace will be controlled by the Induced Draft ("ID") fans installed at outlet of boiler. These fans will be provided with Variable Frequency Drive ("VFD") in order to optimize the power consumption. ID fans will discharge flue gases.

After complete combustion in furnace the flue gases shall enter the super heater section installed in the upper portion of the furnace. From the super heaters, the flue gases will flow downwards into modular bank. The evaporator section of the boiler will be designed for a large circulation ratio. Even during quick plant load changes the water circulation will be stable and thus prevent steam blockage in the evaporator sections.

From evaporator section, the flue gas shall enter the bare tube economizer from the top and leave at the bottom to Air Flue Gas Preheater. The economizer tubes will be supported in the structure of the economizer casing and will be bottom supported. The economizer will be fully drainable.

Thereafter, the Fly Ash Arrestor installed at the outlet of the Air Preheater. From Fly Ash Arrestor, most of the fly ash will be separated from the flue gases.

The condensate from the sugar mill shall be directly fed into the condensate tank from where it will be pumped to the deaerator via sugar plant exhaust condensate pumps through a level control system.

Demineralized ("DM") water will be supplied to the boiler for makeup. The makeup water will be pumped to the overhead surge tank via DM water distribution pumps. The makeup water will be added in the condenser hot well from the overhead surge tank by gravity through a level control system. The condensate from the condenser and makeup water added to the condenser hot well will be pumped to the deaerator by condensate extraction pumps.

3x50% Boiler Feed Water ("BFW") pumps shall be provided. BFW pumps are multistage, centrifugal type with low voltage 415V drive motors with VFDs. The condensate and make-up water lines will have level control valve to control deaerator level.

The control philosophy, boilers interlock and protection logic shall be implemented in Distributed Control System ("DCS") for safe operation of boiler.

7.2 Steam Turbine and Auxiliaries

7.2.1 Steam Turbine

The turbine of the cogeneration power plant will be multistage nozzle governed, horizontal spindle, two bearings, and extraction cum condensing type with 2 number of uncontrolled extractions and 1 number of control extractions. The exhaust from the turbine will be condensed in the surface condenser at 0.1 bar (a) pressure during off-season operation.
The low-pressure steam at 2.5 bar (a), 130^{0}C will be supplied to the sugar plant for juice heating in the evaporator station. The medium pressure steam at 5 bar (a), 155^{0}C will supplied for

centrifugal washing. 95% condensate of the supplied LP steam will be returned from the sugar mill. There will be no condensate return of medium pressures steam.

7.2.2 Gear Box

Heavy duty reduction gear box of Double helical type with hardened & ground gears will be installed, capable of transmitting maximum power generated by turbine and able to withstand 20% over speed over a period of minimum 5 minutes.

The gear box will be designed with a service factor of 1.3 as per AGMA requirements.

7.2.3 Couplings

High speed coupling between the turbine & the gear box will be non-lubricating, steel laminated, flexible type. The coupling between the gear box and the alternator will be low speed. Both the couplings will have coupling guards and acoustic covers. Power rating of the couplings shall be in accordance with AGMA 514

7.2.4 Condensing System

Condensing system shall comprise of the following:

- Shell & Tube horizontal type surface condenser with integral hot well, thermal relief valve and atmospheric relief valve.
- Steam Ejector system consisting of:
    - Twin stage main ejectors (1 working + 1 standby) with two surface type inter and after condensers.
    - Startup hogging type ejector with silencer.
- Vertical canister type Condensate extraction pumps (CEPs), with a 3 x 50% capacity with LT motors and suction valves.
- Rupture disc for condenser protection.
- Expansion bellow with spool piece between turbine exhaust and condenser inlet
- Dry air/vapor line within specified battery limit

7.3 AC Generator

AC Generator shall comprise of the following:

- Brush-less exciter with PMG
- Air coolers
- Twin bearings
- AVR cum Excitation panel
- Anti-condensation heaters
- Water leakage detector- 1 per cooler
- Lube oil flow regulator - 1 per bearing

Generator electrical output rating shall be as follow:

- 33.125 MVA rated capacity at [50]° C ambient.
- [11] ± [10]% KV
- [50] ± [5]% Hz
- 3 Phase
- Power factor ([0.8] lag to [0.95] lead)
- ± [0.5]% Accuracy Control for Excitation system

7.3.1 Generator Protection and Control System:

Generation protection and control system will consist of the following equipment:

- Generator protection (Relay) Panel
- Metering & Synchronizing Panel
- MCC Panel
- Lightning arrestor, Surge capacitor and Potential transformer (LA, SC & PT) Panel
- Neutral grounding resistor (NGR) Panel
- DC Distribution

7.4 Governing System

The governor system provided will control the acceleration of the turbo generator and prevent over speed without tripping the unit under any operating condition or in the event of maximum load rejection.

The governor system will have the following important functions:

- Speed control
- Over speed control
- Load control
- Inlet steam pressure control
- Extraction pressure control

7.5 Lubrication and Control System

A single forced feed lubrication system will be installed for Turbine, Gearbox & Alternator comprising of the following major components:

- Lube oil tank
- Oil Vapor extractor
- AC Electric Main Oil Pump (MOP) driven by gearbox low speed shaft
- AC electric Motor driven Auxiliary Oil Pump (AOP)

- DC Motor driven Emergency lube Oil Pump (EOP) with auto cut-in & cut-out facility
- Lube oil coolers (1working + 1 standby)
- Lube oil filters (1working + 1 standby)
- AC motor driven oil mist separator mounted on oil tank

7.6 Control Oil System

Control oil system will comprise of the following:

- AC electric Motor driven Auxiliary Control Oil Pump (ACOP) (1 working + 1 standby) to supply oil to Control system.
- Control Oil filter (COF) (1 working + 1 standby)

7.7 Main Cooling Water Pumps

The cooling water system shall be designed to provide cooling water to the following area of the plant:

- Surface Condenser
- Auxiliary cooling water coolers

The cooling water system includes the following major components:

7.7.1 Main Cooling Water Pumps

Three (3) Main Cooling Water Pumps (two working and one standby) each of capacity approximately 2600 m^3/hr shall be provided. Pumps will be horizontal centrifugal type, driven by electric motors.

7.7.2 Auxiliary Cooling Water Pumps

Two (2) Auxiliary Cooling Water Pump (One working and one standby) will be provided. Pumps will be horizontal centrifugal type driven by electric motors.

7.7.3 Cooling Tower System

The Cooling Tower System shall have the following specifications:

- One (1) R.C.C structure mechanically induced draft, counter flow type cooling tower
- Capacity of cooling tower will be approximately 6600 m^3/hr and is combined and common for the whole cogeneration power plant.
- There shall be 2 cells each having a capacity of approximately 3300 m^3/hr.
- The cooling tower will be designed for a cooling range of 10°C, and an approach of 4°C while operating under the atmospheric wet bulb temperature of about 30°C.
- Each cell of cooling tower gear box will be equipped with vibration switches, oil temperature and oil level controls.
- The source of cooling water will be Bore Well Water.

- Cooling water supply and return temperature is 34°C and 44°C respectively.

7.8 Raw Water System

Raw water system consists off the following components:

7.8.1 Cooling Water Makeup Pump

Two (2) Cooling Tower make up Water Pumps for season and off-season operation will be provided.

7.8.2 Raw Water Transfer Pumps

Two (2) Raw Water Transfer Pumps (one working and one standby) each of capacity 20 m^3/hr will be provided to ensure raw water supply to Water Treatment Plant.

7.9 Compressed Air System

The function of this system is to provide service and instrument air for cogeneration plant operations. Compressed air system provides air to following users:

- **Instrument Air Users**: Instrument air will be required for the operation of pneumatic instruments like I/P converters, purge instruments, pneumatic actuation of control valves, dampers etc.
- **Service Air Users**: Service air will be required for cleaning of filters, strainers and general purpose.

7.10 Bagasse Handling System

The bagasse handling system comprising of chain conveyors & belt conveyors to transport the required quantity of bagasse from sugar mill to cogeneration shall be provided. Bagasse from the sugar mill shall be fed to the boiler from a front mounted chain conveyor. Excess bagasse shall be returned to the bagasse storage yard. During off-season/non-availability of bagasse from mill, the cogeneration boiler shall use saved bagasse from the storage yard.

7.11 Ash Handling System

The ash handling system envisaged for the cogeneration boiler shall consist of Submerged Ash Belt Conveyor System and Dense Phase Ash Handling System.

7.11.1 Submerged Ash Belt Handling System

Submerged Ash Belt Handling System consists of conveyor belts, drive assembly, all type of pulleys, all type of idlers, bearing assembly, inlet / outlet chutes, take-up assembly, trough assembly, support frames, cross over, walkway, structural safety switches, water inlet / outlet / drain nozzles etc. The bottom ash at the discharge of travelling grate shall be conveyed by submerged ash conveyor system.

The ash shall be quenched in the water trough of submerged ash conveyor before conveying. The submerged ash conveyor shall discharge the ash directly to a trolley mounted tractor for further disposal.

7.11.2 Dense Phase Ash Handling System

This system will handle fly ash from boiler ash hopper (other than traveling grate & plenum ash hopper) and ESP hoppers. Surge hopper (water cooled for boiler ash hopper and non-water cooled for ESP hopper) arrangement shall be provided below the boiler and ESP hopper. Two air compressors with built in PLC control system and 1x100% air receiver shall be provided near the dense phase equipment. The required conveying air for dense phase ash system will be supplied by these compressors through air receivers. The ash silo storage capacity shall be enough to store 12-hours ash generation from both the boiler and ESP system.

7.12 Water Treatment System

The Cogeneration power plant make up water requirements will be met from the bore wells located in the sugar plant. For the make up for the cycle, it is proposed to take the raw water through a Water Treatment Plant with the following treatment scheme.

2 x Multi-grade Filter → 2 x Two Stage Reverse Osmosis system → 2 x Electro De Ionization system.(2x MGF + 2xRO +2x EDI)There shall be two independent streams. The capacity of water treatment plant is 30 m^3/hr. DM water is collected in two DM water tanks each having a capacity of 200 m^3. Water will be distributed from DM tanks through pumps to different users i.e. Deaerator, Condenser etc.

7.13 Firefighting System

The function of fire-fighting system is to supply water to the main risk areas of the cogeneration power plant.

The fire protection system is required for early detection, containment and suppression of fires. A comprehensive fire protection system shall be provided to meet the above objective and all statutory and insurance requirements of National Fire Protection Association ("NFPA").

The fire-fighting system shall consist of the following:

7.13.1 Stand Pipe and Hose System:

Stand pipe and hose system shall be provided to cover the building and structures of the cogeneration plant. The system shall be designed as per the NFPA 14.

Standpipe shall have a hose of 65mm diameter with connection to a large supply of water. The hose connection shall be not less than 0.9m or more than 1.5m above the floor.

7.13.2 Fire Hydrant and Water Monitoring System

The hydrant system shall be provided to cover all areas. The system shall be designed as per NFPA 24. The system shall consist of over ground hydrant mains laid in rings, isolation valves, and stand pipes with hydrant valves (outdoor). A Hydrant shall be placed after every 40m.

7.13.3 Portable Fire Extinguishers:

Dry Chemical Powder, CO^2 and foam type extinguisher system shall be provided. The equipment shall be designed as per NFPA 10.

7.13.4 Automatic High Velocity Water Spray Nozzle System:

Automatic High Velocity Water Spray Nozzle System shall be provided along with deluge valve assembly for outdoor transformers in switchyard, generator & Turbine lube oil system area. The system shall be designed as per NFPA 15. The deluge valve assembly shall be UL/FM listed.

7.13.5 Fire Alarm & Detection System

Fire detection system for the power plant will provide early detection of fire and raise alarm. A comprehensive fire protection system shall be planned to meet the above objective and meet all statutory and insurance requirements of NFPA. A multitude of systems will be provided to combat various types of fires in different areas of the plant and all such systems for various areas shall form a part of a centralized protection system for the entire plant. Fire alarm system detection system shall be provided in following areas:

- Firm alarm and signaling in all electrical/instrumentation panel rooms in TG building
- Manual call points and Electric Horns in outdoor areas.

7.14 Effluent Handling System

Effluent handling system consists of the following main components:

7.14.1 Neutralizing Pit

Acid/caustic produced (if any) from Water Treatment Plant will be collected in neutralization pit. This effluent will be transferred to effluent pit after neutralization.

7.14.2 Neutralized Effluent Re-circulation cum Transfer Pumps

Two (2) Neutralized Effluent Re-circulation cum Transfer Pumps (One working & one standby) shall be installed at Neutralization pit to transfer effluents from Neutralization pit to Effluent pit in water treatment plant area.

7.14.3 Effluent Pit

Effluents like Boiler blow down, cooling tower blow down, RO reject, MGF backwash, side stream filter flushing, RO flushing, neutralized effluent from neutralization pit, etc. shall be collected in the separate effluent pit near Water Treatment Plant area.

7.14.4 Effluent Transfer Pump

Two (2) Effluent Transfer Pumps (One working and one standby) will be installed on Effluent pit to transfer effluents. The pumps will also be used to re-circulate the effluent with in Neutralization pit for effective neutralization. The pump capacity shall be minimum 200 m^3/hr.

7.15 Service Water System

Two (2) service water pumps (One working and one standby) will be installed to provide service water to plant users. One (1) expansion vessel will be installed to keep service water header pressurized.

7.16 Electric Overhead Travelling (EOT) Cranes

EOT cranes shall be provided in the following buildings:

TG Hall

An Electrically operated EOT crane shall be provided for the erection and maintenance requirements of turbo generator and its auxiliaries.

The main hook capacity shall be 70 Tons and suitable for lifting single heaviest component in Turbo Generator. The auxiliary hook lifting capacity shall be of 5 Tons. The crane travel will cover the entire length of the TG building. The crane shall be electrically operated, bridge type and shall be designed and equipped for indoor operations complete with all accessories. The crane bridge shall consist of bridge girders each carrying a rail on which a wheeled trolley is to run. Operation of crane shall be by pendant type push button station from ground level.

Workshop and Store

An Electrically operated EOT crane shall also be provided for routine maintenance activities and store material handling to be carried out in the building.

The single hook crane capacity shall be 5 Tons. The crane travel will cover the entire length of maintenance bay of workshop. Operation of crane shall be by pendant type push button station from ground level.

8 Electrical Design

8.1 Electrical Network

The Plant shall consist of one generator and associated auxiliaries for smooth plant operation. A synchronous alternator for the proposed co-generation power plant with generation at 11 kV will be connected to a 132kV system through 11kV switchboard and step-up Power Transformers.

The connection between generator and 11kV switchboard shall be through phase segregated Phase Bus Duct and between 11kV switchboard and 11/132kV power transformer shall be through 11kV HT XLPE cables.

The generator will operate in parallel with NTDC National grid. A portion of the power generated in the turbo-generator will meet the power requirements of the Cogeneration plant auxiliary loads and the sugar plant loads through step down transformers.

The surplus power, after meeting the power requirement of cogeneration plant auxiliaries and sugar plant auxiliaries, shall be exported to the grid through 11/132kV power transformer. There

shall be total of 2 step-up power transformers (one working + one standby) to meet N-1 condition of NTDC.

Entire power evacuation system and associated equipment shall be designed so as to export the entire power from cogeneration plant (total generation less auxiliary power consumption), when the sugar plant is not in operation.

All the existing sugar plant loads shall be fed through one (1) 12.5MVA 11/3.3kV interconnecting transformer for existing loads and proposed 11kV sugar switchboard for mill house loads.. Power for the 11kV sugar switchboard shall be fed from 11kV cogen switchboard which shall be interconnected through HT cables.

8.1.1 Ambient Conditions for Electrical Equipment

Ambient conditions and design temperatures for electrical equipment are given in Table 6 below:

Table 6: Ambient Conditions for Electrical Equipment

	Deg C
Maximum Temperature	[50]
Indoor Equipment Design	[50]
Outdoor Equipment Design	[50]

8.2 Plant Operating Voltage

The plant shall be designed suitable for operating at a frequency of 50Hz, with voltage levels of various systems of the plant as given in Table 7 below:

Table 7: Plant Operating Voltage

Generation (TG) system	[11] kV
Power evacuation system	[132] kV
Non-AC VSD / auxiliaries of cogeneration plant	[415] V
AC VSD / auxiliaries of co-generation plant	[415] V
DC system of co-generation plant	[110] V
UPS system of co-generation plant	[230] V

8.3 Basic Electrical Design Parameters

Basic electrical design parameters for the Plant are given in the table below:

Table 8: Basic Electrical Design Parameters

Power Factor (lagging)	[0.8]
Generation Voltage (kV)	[11] kV, 3 phase
Parallel operation with Grid	Required with [132]kV grid
Grid Voltage	[132] kV, 3 phase

System Frequency	[50] ± [5]%
System Voltage Variation	±[10]% Variation of Rated Voltage
System Fault Level	
132 kV	[40] kA
11 kV	[40] kA
415 V	[50] kA
Fault Level & Withstand Duration	
132kV Switchgear	[40] kA for [1] sec
For 11 kV Switchgear	[40] kA for [3] sec
For 415 V Switchgear	[50] kA for [1] sec
400V Lighting System	[10] kA for [1] sec
11kV Segregated Phase Bus Ducts	[40] kA for [3] sec
110VDC	[25] kA for [1] sec
48VDC	[10] kA for [1] sec
230VAC	[10] kA for [1] sec
Transformer and all accessories	All transformers and its accessories shall be capable of withstanding for [3] seconds short circuit at the terminal
Earthing System	
132 kV	Effectively earthed
11 kV	Neutral grounded (limited to < 50 A) / Unearthed (Whenever the generator is not in service)
415 V	Effectively earthed
110 V DC	Unearthed

8.4 132kV Switchyard

Switchyard shall be supplied for interface with NTDC Grid in line with following specifications and NTDC requirements. Detailed specifications of the switchyard are given in the table below:

Table 9: 132kV Switchyard Specifications

Voltage Level	[132] kV
Service	Outdoor AIS with SF6 circuit breakers
Number of Bays	[2] OHL Bays [2] Transformer Bays [1] Bus-Coupler Bay
Bus Bar	AAC conductor of "Hawthorn"
Short Circuit SF6, gang operated	[3150] Amp [40]kA [1] sec
Isolator (Centre break, motor operated with copper alloy blades)	[2000] Amp
Protection & Metering	As per NTDC Requirements
Highest System Voltage(kV rms)	[145] kV
Power frequency withstand capability (kV rms)	[275] kV

Basic insulation level (kV peak)	[650] kV
Creepage distance for insulators (mm/kV)	[25]
Instrument Transformers	Hermetically sealed, dead tank design. Rating as per SLD
Insulator	Brown glazed with min 6kN cantilever Strength
Towers & Support Structures	MS galvanized lattice type
Tariff Metering equipment	Three elements four-wire configuration, electronic, digital, with accuracy class of 0.2S; 30 minutes intervals for a period of 70 days with intervals programmable from 5 minutes to 30 minutes

8.5 Steam Generator

Generator shall be supplied in line with the following specifications:

Table 10: Steam Generator Specifications

Description	Parameters
Rating & Count	26.5 MW
Type	Synchronous type
Number of pole & Excitation System	Four pole, with brushless excitation system.
Power Factor	[0.8]PF (lagging) to [0.95] (leading) under entire band of ±[10]% voltage variation and ±[5]% frequency variation
Insulation Class	Class 'F' insulation and shall be suitable for operation within class 'B' limits
Overload Requirements	Over loading of 110% for one hour every 12 hours and 150% for 30 seconds
Short Circuit and Overload Endurance	Generator shall withstand short-circuit of any kind at its terminal, while operating at rated load and 105% rated voltage for at least 3 seconds

8.6 Segregated Phase Bus Duct

Generator shall be connected to 11kV panel through Segregated Phase Bus Duct with Copper conductors. All other electrical distribution connections shall be through MV or LV rated cables as per application and voltage grade. Technical details of the Segregated Phase Bus Duct are given in the table below:

Table 11: Segregated Phase Bus Duct Specifications

Application	Steam Generator Connection to 11kV Panel
Power Frequency Withstand Voltage	28kV
BIL	75kVp
Enclosure	Minimum thickness of 3mm

Sizing Basis	Maximum through fault current either from 132kV grid or from the generator including contribution from total plant loads through Auxiliary Transformers with 20% margin on higher side or 50kA, whichever is higher

8.7 11kV Switchboard

11 kV switchgear shall be of indoor, metal clad, fully draw out truck type with vacuum circuit breaker. The switchgear shall be suitable for maximum system voltage of 12 kV. The power frequency voltage of the board shall be 28kV and BIL of the panel shall be 75kV (peak). The circuit breakers and switchgear assembly shall withstand the rated short circuit current for not less than three seconds. The breakers shall also be rated for peak asymmetrical current with a rating of 2.5 times symmetrical rated current. The switchboard shall have incomer, Tie, Bus coupler and outgoing feeders of rating 3150A / 2000A / 1250A for distribution of power to cogen and sugar plant and power export.

8.8 3.3kV Panel

One (1) 3150A 3.3kV VCB stand-alone panel shall be provided for feeding power to existing sugar plant loads through 12.5MVA 11/3.3kV Interconnection transformer, which shall be provided in between the 11kV sugar switchboard and 3.3kV stand alone panel.

8.9 415 V Switchboard

All the cogeneration plant auxiliary loads shall be segregated into AC Variable Speed Drive (AC VSD) driven loads and non-AC VSD driven loads.

All AC VSD loads pertaining to cogeneration plant shall be connected to one (1) of 11/0.415/0.415kV AC VSD transformer and non-VSD loads shall be connected to one (1) of 11/0.415kV AC VSD transformer. Both the VSD and non-VSD switchboards shall be interconnected through tie ACB feeders. DG incomer shall be provided in the non – VSD switchboard to meet the plant startup / emergency loads. These switchboards shall be designed for 50 kA for 1 sec. The busbar material of the panel shall be of copper.

8.10 Transformers

Technical specifications of the different transformers to be installed in the Project are given in the table below:

Table 12: Specifications of Transformers

Description	Parameters
Generator transformer (GT) / Power Transformer	[28/35] MVA [132/11] kV YNd11
VSD transformers [Three winding transformer] for co-generation plant	3.15 MVA 11/0.415/0.415 kV, Dyn11Dzn0
Interconnection transformer at sugar plant	12.5MVA, 11/3.3kV, Dyn11

Lighting Transformer	150kVA, 415V/400V, 50Hz, Dyn11, dry type, Three Phase, Two Windings
Neutral Grounding Transformer	Zn0 windings, 50A for 10Sec & 500A for 3Sec, 11KV, ONAN

8.11 AC & DC UPS System

AC and DC UPS system will be supplied for loads that require un-interrupted power. Following UPS shall be supplied for this purpose:

Table 13: AC & DC UPS Specifications

Description	Parameters
110VDC for TG system	1x100% Dual FCBC with Battery Bank [VRLA Type]
110VDC for Switchyard	2 sets of Battery banks SMF type 2V Cell batteries, suitable for 110V DC system along with FCBC.
230VAC UPS	2x100% Dual Redundant UPS with Dedicated Battery Bank [SMF type: Sealed Maintenance Free]
230VAC Emergency Lighting inverter	Minimum 16kVA inverter with battery backup

8.12 Control Philosophy & Interfacing

Critical and important electrical loads shall be interfaced with SCADA system [built in plant DCS] for local and remote operation in-line with plant operational & safety requirements.

8.13 Energy Management System

The incoming and outgoing feeders of 132kV Switchyard Bays, Main MV [PCC] Panel and AC-VSD panel outgoing feeders shall be provided with PQM/TVM with communication port suitable for MODBUS-RTU protocol. One daisy chained link shall be provided for each switchboard which will communicate soft data to Plant DCS. All these meters shall be hooked up to a dedicated Energy Management System for data logging built in plant DCS.

Communication ports of MODBUS - RTU shall be planned in all TVMs and PQMs provided in the PCCs, AC VSD panels and control panels of the TG, Generator Transformer and switchyard control and relay panels. All the ports shall be hooked up to Energy Management System (Part of DCS) for data logging as well as monitoring purposes. The mimic representation of the complete electrical distribution shall be provided in Energy Management System (part of DCS) from 132 kV level to major/main LT panels.

8.14 RTDs & Thermistors

Thermistors shall be installed on motors rated between [30] to [75] kW. RTD shall be made available for motors rated from [90] kW and above. All RTDs shall be hooked up with relays in Motor Relays in respective MCC.

8.15 System Earthing

The grounding installation work shall be as per recommendation of IEEE-80. All panels, transformer, LAVT, NGR and motors shall be provided with double earthing. Lightning protection for tall structure shall be in line with IEC standards.

132kV system shall be solidly grounded through 132 kV side of transformer neutrals at NTDC side as well as neutral of generator transformer on 132 kV side at co-generation plant.

TG system shall be grounded through Neutral Grounding Resistor ("NGR") panel to limit the earth fault current to [50] A to suit the system requirement, through the [11] kV neutral point of TG. The [11] kV system shall be provided with 11 kV Earthing Transformer and Neutral Grounding Resistor (NGR) panel to limit the earth fault current to 50A. This NGR of earthing transformer shall be switched ON whenever the power is imported from the grid with TG circuit breaker in open condition. The [3.3] kV system at the secondary side of Interconnection Transformer shall be provided with NGR grounding to limit earth fault current of [100] A.

LV system 415V system shall be solidly grounded through transformer neutral. Neutral busbars shall be made available in 415V PCCs, and all MCCs.

415V VSD transformer grounding system shall be as for 6 Pulse AC VSD drives – Solidly grounded.

400V system used for illumination system and small power distribution system shall be solidly grounded.

UPS System shall be of insulated neutral type (ungrounded). DC System shall be of ungrounded type.

8.16 Cable Installation

Cables shall be installed in concrete cable trenches [installed on trays], on cable racks and direct buried as required. All outdoor cables shall be laid on over head cable trays. No cables shall be buried, except for outdoor lighting cables. Outdoor cable racks shall have clearance of minimum 6 M between the ground level and the lowest point of the cable racks.

8.17 Cable Trench

Concrete cable trenches shall be fitted with ventilation fans, air inlets, normal lighting, emergency lighting, utility sockets, fire alarm detectors, manual call points, and annunciation sirens. All wiring shall be in GI conduits.

Trench shall have access inlets provided with ladders, slopped on two sides having water excavation pits and two pumps.

8.18 Lighting & Small Power

Plant lighting loads shall be fed through One (1) No. of 415/400V, Dyn11 connected dry type lighting transformer of minimum rating of [150] kVA.

Emergency Lighting Distribution Board ("ELDB") shall be fed through inverter of minimum [16] kVA rating.

The number of sockets [where maintenance & operation is required] shall be provided in the indoor area in such a way that approachable distance of any socket is not more than 10M distance. Minimum four (4) nos. of 24V lighting kit shall be provided for the plant.

63A power and welding socket shall be provided in all indoor as well as outdoor area wherever maintenance of mechanical equipment is required. Each socket shall comprise of MCB with ELCB and power / welding socket.

8.19 Plant Communication System

Plant communication shall be provided with following facility:

- Telephone system
- Public Address System
- Walkie-talkies.

8.20 Enclosure Ratings

Enclosure IP ratings for different applications shall be as below:

Table 14: Enclosure Ratings

HV Switchgear	IP4X
LV Switchgears	IP4X
Switchgears located outdoors	IP55
Control Panels	IP42
Motors	IP55
Push Button Stations	IP54 (indoor) IP55 (outdoor)
Segregated Phase Bus ducts	IP54 (indoor) IP55 (outdoor)

8.21 Plant Startup

The co-generation plant shall be started with two (2) numbers of 415V Black start DG sets. These DG sets shall be connected to DG panel, which shall be planned with two incoming DG set feeder and two outgoing feeders.

Plant startup can also be managed either from Grid supply or Black start DG sets.

The DG set shall be with radiator cooled type. Proposed rating of each DG set shall be minimum 1500kVA at Prime duty

8.22 Instrumentation and Control ("I&C") Systems

I&C System will ensure control and monitoring of operations of both the technological and electrical part of Cogen Power Plant including balance of plant (auxiliary operations) and 132 kV switchyard. Control room and its auxiliary equipment will be located in an outbuilding ("CCR") adjacent to the Turbine Hall. I&C System will be designed as a complex system capable to control the whole Cogen unit both in standard conditions and transient operating conditions (start-up, shutdown, etc.). Specific autonomous functions of protections and control for steam turbines will be performed by their dedicated control system, nevertheless this dedicated control system will be an integral part of the whole I&C System from the viewpoint of operation, monitoring and control. I&C System will ensure control and monitoring of the following equipment:

- Boiler and its Auxiliaries
- Fuel Handling System
- Ash Handling System
- Steam turbine with accessories
- Balance of plant
- Electric equipment of Switchyard

8.23 Digital Control System ("DCS")

The controlling and monitoring of operation of main power unit, loading and synchronizing, balance of the plant will be provided from the common control room through the operator panels of the process, electrical part including power outlet equipment, frequency control and switchyard etc. The working place of the system operator will be placed at the control room. The working place of shift engineer will be located in a separate room with the window to the control room. The DCS will be based on fully redundant process and network bus. The power plant will be fully automated with a target of high operation reliability as well as high operation safety. Control system will fulfill required standard functions for securing optimal, economical, safe and ecological operation for installed equipment in nominal and transient operation conditions. System will cover control function from basic level control up to fully automated control of function groups and units, control of system output and optimization of block operation. Specific autonomous functions of the plant safety system and selected regulation and control functions will be realized by special subsystems in a hierarchical model. From a viewpoint of control, these items will create an integrated part of the DCS control system.

Hardware and software will enable realization of loop control, binary control, data functions, monitoring, remote control and emergency manual control. Communication within the system will be handled by bus routing connected to the standard bus system RS 485, Ethernet etc.

8.24 Field Instrumentation

Instrument power circuits will employ an isolation transformer and will be individually protected from fault with the help of MCB's and fuses. Power supply to the individual instrument will be disconnect-able with the help of switch and will be protected with the help of fuse.

All instruments and equipment will be suitable for use in a hot, humid and tropical industrial climate. All instruments and enclosures in field will be dust proof, weather proof of type NEMA 4 and secured against the ingress of fumes, dampness, insects and vermin. All external surfaces will be suitably treated to provide anti-corrosion protection.

The complete instrument system will be designed for safe operation, by using normally closed contacts which open on fault conditions.

The operating value of field instrument will fall between 40% and 60% span for linear and 60% to 80% span for square root.

Transmitter valve manifold block assemblies will be type 316 stainless steel unless process conditions require higher-grade material. Internal wetted parts will be type 316 stainless steel unless process conditions require use of other material.

Process switches e.g. pressure switch and level switch will be of micro switch type.

All field-mounted instruments will be equipped with sufficient isolation device such as a block and bleed valves assembly, and vent and drain valves to permit safe maintenance, removal, testing and calibration of instruments during plant operation.

9 Grid Interconnection

A detailed grid interconnection study has been carried out and submitted to HESCO for approval. A summary of the submitted report is given below:

- The Network around MEL at 132 kV and 11 kV has been modeled as shown in Annexure-2 (Sketch-1).
- The nearest HESCO grid facility available for interconnection to MEL is existing 132 kV circuit between Mirpurkhas 132 kV grid station and Usman Shah 132 kV grid station.
- Keeping in view the location of the Project, the most feasible interconnection scheme would be looping in-out the existing 132 kV circuit between Mirpukhas to Usman Shah at MEL. The looping distance as confirmed from site visit would be 1 km and the conductor used would be lynx. The scheme is attached as Annexure-3 (Sketch-2).
- MEL would generate power at 11 kV voltage level from where it is stepped-up to 132 kV using two 132/11 kV transformers with rating of 31.5/40 MVA.
- The proposed scheme would require two 132 kV line bays at the 132 kV substation of MEL for the connection of 132kV circuit to both Mirpurkhas and Usman Shah Grid stations. Furthermore, it would also require two transformer bays for the connection of two 132/11 kV transformers with rating of 31.5/40 MVA.

- With the gross capacity of 26.5 MW, the spillover from MEL would be 23.75 MW in Off-Season and 21.11 MW in the Crushing Season
- In view of planned COD of the Mehran Energy PP in November 2018, the above proposed interconnection scheme has been tested for steady state conditions through detailed load flow studies for the peak conditions of:
    - January 2019 for maximum thermal power dispatches in the grid during the Crushing Season for MEL.
    - September 2019 for maximum hydropower dispatches in the grid during the off-season of MEL.
- The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.
- The proposed scheme of interconnection has also been tested for the extended term scenario of peak load conditions of the year 2021 for steady state conditions.
- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the spillover of up to 23.75 MW power of the Plant under normal as well as contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at MEL and the substations of 132 kV in its vicinity. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear installed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from MEL.
- The maximum short circuit levels of MEL 132 kV is 6.90 kA and 5.10 kA for 3-phase and 1-phase faults respectively for the Year 2019 and 7.11 kA and 6.95 kA for 3-phase and 1-phase faults respectively for the Year 2021. It would be advisable to go for standard size switchgear of short circuit rating of 40 kA. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.
- The dynamic stability analysis of proposed scheme of interconnection has been carried out for January 2019. The stability check for the worst case of three phase fault right on the 132 kV bus bar of Mehran Energy PP substation followed by the final trip of one 132 kV circuit emanating from this substation, has been performed for fault clearing of 5 (100 ms) and 9 cycles (180 ms), in case of stuck breaker, as understood to be the normal fault clearing time of 132 kV protection system. The stability of system for far end faults of 3-phase occurring at 132 kV bus bar have also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults for the most stringent cases. The system is found strong enough to stay stable and recovered with fast damping.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load

flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

10 Environmental Impact Assessment

The analysis performed to fulfill the EIA/IEE requirement follows international standards. The EIA establishes the baseline condition of the site and assesses the impact of the proposed generation facility on area resources. The likely positive and negative impacts of the proposed project are identified and quantified to the extent possible. Mitigation measures to be taken during construction and operation of the facility and any residual negative impacts are identified.

- The planned generation facility is a state of the art combined cycle unit and will meet all applicable international standards for air emissions.
- An Electrostatic Precipitator (ESP) will be used to collect the fly ash and together with the bottom ash from the boiler, the bagasse ash will be used as manure / fertilizer on corporate farms and also made available to growers in the region.
- The Effluent generated from Co- generation power plant will be neutralized and will be treated into the existing sugar ETP. The treated water from the sugar ETP will be used for agriculture purpose and for sprinkling inside the plant boundary wall and left over if any, discharged into the nearby farms of Mehran Energy Limited.

In summary, the planned facility meets all international environmental standards and will have a positive impact on the local economy without stressing the local infrastructure and services. In addition, the facility will alleviate many of the severe problems currently being experienced in the Albanian electric power system.

11 Operations and Maintenance (O&M)

The Facility will be a standalone operation under the management of the Plant Manager who shall oversee both, technical and administrative functions of the co-generation facility's operation and maintenance. Most operation and maintenance functions will be performed by permanent staff. However, certain functions, such as performance monitoring of equipment, environmental monitoring, fuel yard operation, ash handling and major maintenance, will be performed under various contracts with specialized vendors. The contracts will be equipment specific performance monitoring and maintenance contracts and will also include contracts for supply of manpower for major maintenance activities. To the extent practical, the operation of the Facility will be automated through a distributed control system.

The Facility operation is planned to be divided into three shifts with a fourth shift in reserve. Each operating shift will include a shift charge engineer, one control room operator, one operator, one boiler operator two field operators and a chemist. All the operations staff will report through the shift charge engineers who report to the Operations Manager reporting to Plant Manager

The maintenance of the Facility will be divided into three work areas – instrumentation, electrical, and mechanical. Each work area will be managed by a manager who reports directly to the Plant

Manager. Maintenance staff reporting to the managers will be provided on each shift. The total maintenance staff is as follows:

The maintenance staff will perform the routine maintenance on the Facility. During the off-season periods when the Facility is not operating, the maintenance staff will support any major maintenance work that needs to be performed.

In addition to the operation and maintenance departments, there will be a separate performance department and a fire and safety department. The staffing for these two departments is as follows:

Table 15: O&M Staffing

Mechanical Maintenance		Electrical Maintenance		Instrumentation & Control	
Manager – Mechanical	1	Manager – Electrical	1	Manager – I&C	1
Mechanical Engineer	1	Electrical Engineer	1	I&C Engineer	1
Mechanical Supervisor	1	Electrical Supervisor	1	I&C Supervisor	1
Mechanic/Fitter	8	Electrician	5	I&C Technician	5

The performance/efficiency engineer will be responsible for monitoring the operation of the Facility and identifying any operational issues that affect the performance of the Facility. Additional responsibilities include maintaining the plant design records and drawings.

Hence the total operation and maintenance staffing, including the Plant Manager, is 64. This excludes the contract operation and maintenance staff.

11.1 Maintenance of the Plant

Routine maintenance of the Project will be performed on a shift basis. Most of the routine maintenance activities are expected to be preventative maintenance work and troubleshooting during the time the Facility is operating. There will be sometime during the off-season where the Facility will not be operating due to unavailability of bagasse or other appropriate biomass fuels. During these non-operating periods, which shall last up to one month during a given year, the maintenance staff can perform more extensive repairs.

The major maintenance cycle for the key components will be a function of the number of operating hours accumulated. Given the expected downtime during the off-season, it is logical to expect boiler inspections, cleaning and repairs to be performed each year. The annual boiler work would include measurement of tube thickness in certain areas of the boiler, weld repairs where there is localized tube metal loss, tube replacements where the metal loss is more extensive, refractory repairs, grate bar replacements, grate chain adjustments, ash system repairs, etc. Extensive repairs would not be required for the first ten years of operation, particularly if the fuel burned is primarily bagasse and the operating period is less than 180 days a year.

Major maintenance on the steam turbine and generator is to be performed on a five to seven year basis for a base loaded plant. A thorough inspection of the steam turbine and generator is expected prior to the expiration of the supplier warranties. After that, given the expected operating regime of 180 days per year, the first major inspection of the steam turbine and generator would not be anticipated for ten years unless there are indications of some mechanical or electrical failure.

12 Key Operating Assumptions

The following sections provide a summary of the general, project cost, operating and financing assumptions related to the Project. The feasibility has been prepared following a detailed discussion of these assumptions with Project sponsors. The proceeding sections discuss the following assumptions:

- Plant Generation
- General & Timeline
- Project Cost
- Financing Assumptions
- Project Tariff & Revenue
- Operating Cost Assumptions (including fuel)

12.1 Plant Generation Parameters

As discussed earlier, 26.50 MW steam turbine generator shall be provided steam by the HP boiler. During the crushing period, the HP boiler and steam turbine shall meet the steam and power requirements of MSML to the extent these are not met by the LP boiler. To meet the steam requirements of the MSML process, the current LP boiler along with a 9.43 MW (Net) backpressure turbo generator shall be operational during the crushing period. The steam generation through the LP system shall only be available during the season and will be dedicated to the sugar mill. Key generation parameters during are as follows:

Table 16: Plant Generation

	Crushing Period	Non-Crushing Period
Extracting & Condensing Turbine Capacity	25.98 MW	26.50 MW
Auxiliary Consumption of Turbine	2.34 MW	2.25 MW
Net Capacity from HP System	23.65 MW	24.25 MW
Gross Capacity of Backpressure Turbo generator	10.18 MW	n/a
Auxiliary Consumption of Backpressure Turbo generator	0.75 MW	n/a
Net Capacity of LP System	9.43 MW	n/a
Sugar Mill Requirement	11.97 MW	0.50 MW
Net Exportable to Sugar Mill from HP System	2.54 MW	0.50 MW
Net Exportable to Grid from HP System	21.11 MW	23.75 MW
Exportable Units	47,366 MWh	48,781 MWh

12.2 Project Timeline

As per discussions with the Sponsors a 20-month construction time following financial close has been assumed for the Project. Financial Close is targeted in end July-early August 2017 with a target Project commercial operations date ("COD") of end-March 2019. This would enable the Project to smooth any teething issues that may arise during the crushing period. A schedule of activities and key milestones is provided in Table 17 below.

Table 17: Indicative Project Schedule

Activity	Duration	Start Date	End Date
Issuance of LOI			7-Nov-16
EPC Activities	120	7-Nov-16	7-Mar-17
Grid Study, Approvals & CPPA-G Consent	120	7-Nov-16	7-Mar-17
Generation License Application and Approval from NEPRA	60	30-Jan-17	31-Mar-17
Tariff Application and Approval from NEPRA	30	7-Mar-17	6-Apr-17
Issuance of LOS	15	6-Apr-17	21-Apr-17
Signing of IA and EPA	60	21-Apr-17	20-Jun-17
Financial Close Activities	120	6-Apr-17	4-Aug-17
Construction Activities	600	4-Aug-17	27-Mar-19
Commercial Operations Date			27-Mar-19

12.3 Project Life

As per the standard energy purchase agreement ("EPA") the Project life and EPA term has been assumed as 30 years from COD and all equipment is being procured corresponding to the same.

12.4 Project Cost

The break-down of the estimated Project Cost is provided below in Table 17. The Engineering, Procurement & Construction Cost accounts for 80% of the total Project Cost. The project cost is based on an average PKR/USD exchange rate of PKR 109.19/USD. It may be noted that only 40% of the devaluation over the construction period is to be adjusted in the final tariff to be determined by NEPRA.

Table 18: Estimated Project Cost

Estimated Project Cost*	USD million	PKR million
EPC Cost	26.50	2,893.59
Non-EPC Cost	0.98	107.32
Project Development Costs	2.30	251.61
Insurance during Construction	0.27	28.94
Financing Fee & Charges	0.93	101.59
Interest during Construction (IDC)	2.21	240.93
Total	**33.19**	**3,623.98**
EPC Cost per MW (USD million)	*1.00*	
Project Cost per MW (USD million)	*1.25*	

**Project cost is based on preliminary estimates and will be firmed up when EPC contract is finalized*

- **EPC Cost** at USD 1.00 per kW has been based on applicable costs in precedent transactions with an adjustment for smaller plant size. The Company is in the process of finalizing the equipment for the Project. The Project may opt for EPC or multiple vendor package and this shall be updated in due course.
- **Non-EPC** costs include costs related to:
  - Land cost estimated at USD 0.50 million
  - Non-reimbursable fuel during testing at USD 0.48 million based on an estimated bagasse consumption of 15,000 MT.
- **Project Development** costs include costs related to technical studies, owners' engineer, construction manager as well as legal and other advisors estimated at USD 1.14 million; fees related to NEPRA, AEDB, SECP as well guarantee costs estimated at USD 0.16 million; and Company overheads during the construction period estimated at USD 1.0 million.
- **Construction Insurance** has been budgeted at 1.00% of EPC cost.
- **Financing Fees & Charges** have been estimated in line with precedent transactions and have been budgeted in the range of 3.5% of total debt.
- **Interest during Construction** has been calculated over a 20-month construction period, an 80:20 debt to equity ratio and a lending rate of 3-month KIBOR plus 3.0%. Disbursement over the 20-month period is based on an advance payment of 15.0%; final acceptance payment of 5% and an equal distribution over the remaining 18 months. The payment profile shall be firmed at the time of finalization of the EPC contract(s).

12.5 Project Financing

The Project financing will be based on a debt to equity ratio of 80:20. Under the base case financial projections debt is assumed to be repaid 10 years after COD with debt being amortized over the period through fixed annuity based installments.

Key parameters of the Project funding are provided in Table 19 below:

Table 19: Project Funding

Project Cost	PKR 3,623.98 million
Debt	PKR 2,899.18 million
Equity	PKR 724.80 million
Lending Rate	9.44% *(3-month KIBOR + 3.0%)*
Repayment Period	10 years
Repayment Frequency	Quarterly
Annual Installment	PKR 451.14 million

12.6 Project Tariff

NEPRA had announced a 30-year Upfront Tariff for high pressure boiler based bagasse power projects in May 2013 which was valid for a period of 2 years. Subsequently, the Upfront Tariff was extended up to May 2017 and in the meanwhile an adjusted Upfront Tariff (**"Adjusted**

Upfront Tariff") was announced based on indexations applicable at May 2015. As per discussions with NEPRA, the Adjusted Upfront Tariff shall be applicable for the Project.

The Adjusted Upfront Tariff is calculated on notional capacity of 1.00 MW with appropriate indexing of different tariff determining components. This tariff structure is generic in nature and is applicable for various sizes of new bagasse based co-generation power plants of 60 bar or higher pressure boilers. The critical assumptions upon which the tariff is based appear in the table below:

Table 20: Key Assumptions for Adjusted Upfront Tariff

Description	Basis
Auxiliary Consumption	8.5%
Plant Factor	45%
EPC cost per MW	USD 0.7960
Project Cost per MW	USD 0.9795
Construction Period	20 months
Exchange rate (PKR/USD)	101.60
Benchmark Efficiency	24.5%
Bagasse Price	Linked to CIF Karachi Coal Price, Minimum USD 100.67 per MT
Bagasse CV	6,905 BTU/kg
Total O&M Cost	3.25% of EPC
Variable O&M Local	15% of total O&M
Variable O&M Foreign	45% of total O&M
Fixed O&M Local	40% of total O&M
Insurance	1.0% of EPC
Working Capital	45 days of Fuel @ 3 month KIBOR plus 2.0%
Debt	80%
Return on Equity	17.0%
Return on Equity during Construction	17.0%
Loan Repayment Period	10 years
Repayment Frequency	Quarterly
Debt Cost	3 month KIBOR plus 3.0% (Base KIBOR: 7.99%)

Respective tariff components along with relevant indexations are provided in Table 20 below:

The tariff is payable on a take or pay basis based on the declared availability of the Plant by the Company. Key features of the tariff applicability are as follows:

1. For all energy dispatched to the grid, a tariff based on the sum of indexed values of all the above mentioned components shall be payable.
2. During the crushing period, if the Plant is not dispatched following a declaration of energy a tariff based on the sum of indexed values of all the above mentioned components shall still be payable based on the declared energy.

3. During the non-crushing period, if the Plant is not dispatched following a declaration of energy a tariff based on the sum of indexed values of all the above mentioned components (excluding the fuel and variable components) shall be payable based on the declared energy.
4. All upside and downside risk with respect to the annual generation lies with the Company. In case the Company is able to achieve a plant factor above 45% the full indexed tariff shall be payable.

Table 21: Adjusted Upfront Tariff

Description	Reference Tariff PKR per kWh Year 1-10	Year 11-30	Indexation
Fuel Cost	5.9825	5.9825	Yearly PKR/USD parity and annual CIF Coal Price w.e.f 1st October of each year
Variable O&M – Local	0.1198	0.1198	Quarterly CPI changes notified by FBS on start of each quarter
Variable O&M – Foreign	0.3393	0.3393	Quarterly changes in PKR/USD and US CPI changes notified by Bureau of Labor Statistics on start of each quarter
Fixed O&M	0.3194	0.3194	Quarterly CPI changes notified by Federal Bureau of Statistics ("FBS") on start of each quarter
Insurance	0.2204	0.2204	No indexation
Working Capital	0.1673	0.1673	Quarterly adjustment for changes 3 M KIBOR
Return on Equity	1.0345	1.0345	After onetime adjustment at COD, annual changes in PKR/USD parity
Debt Servicing Component	3.6658		After onetime adjustment at COD, quarterly changes in 3-M KIBOR
Total Tariff	**11.8491**	**8.1833**	
Levelized Tariff	**10.5727**		

Note: The tariff is adjusted quarterly for changes in 3-month KIBOR variations. The financial projections have been prepared on the basis of the recent 3-month KIBOR rate of 6.44% with the tariff and related cost adjusted accordingly.

12.7 Project Revenue

As stated above, the Project shall be selling power to the national grid as well as partially meeting the power and steam requirements of MSML. In such a case, the Project shall be expecting three (3) revenue streams as follows:

- Sale of energy to national grid i.e. CPPA-G
- Sale of energy to MSML
- Sale of steam to MSML

12.8 General

The base case financial projections show that the Project is expected to generate a positive earnings before interest, taxes and depreciation ("EBITDA") and net profits throughout the life of the Project.

12.9 Projected Financial Statements

Projected financial statements and key financial ratios based on the base case assumptions discussed in Section 13 are provided in the following sections. Financial Statements presented below are limited to the 10-year debt period.

12.10 Projected Income Statement

PKR million	1	2	3	4	5	6	7	8	9	10
REVENUE										
Power to Sugar Mill	**84**	**84**	**84**	**84**	**84**	**84**	**84**	**84**	**84**	**84**
Power to CPPA-G	**1,197**	**1,197**	**1,197**	**1,197**	**1,197**	**1,197**	**1,197**	**1,197**	**1,197**	**1,197**
Steam for Sugar Mill	**86**	**86**	**86**	**86**	**86**	**86**	**86**	**86**	**86**	**86**
Total Revenue	**1,367**	**1,367**	**1,367**	**1,367**	**1,367**	**1,367**	**1,367**	**1,367**	**1,367**	**1,367**
Bagasse Cost	675	675	675	675	675	675	675	675	675	675
Local Variable O&M	13	13	13	13	13	13	13	13	13	13
Foreign Variable O&M	46	46	46	46	46	46	46	46	46	46
Local Fixed O&M Cost	36	36	36	36	36	36	36	36	36	36
Total O&M Cost	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**
Insurance Cost	31	31	31	31	31	31	31	31	31	31
Depreciation	121	121	121	121	121	121	121	121	121	121
EBIT	**445**	**445**	**445**	**445**	**445**	**445**	**445**	**445**	**445**	**445**
Working Capital Cost	22	22	22	22	22	22	22	22	22	22
Interest on LT Loan	267	249	230	208	184	158	129	98	63	25
Net Income	**155**	**173**	**193**	**215**	**239**	**265**	**293**	**325**	**359**	**397**

12.11 Projected Balance Sheet

PKR millions	1	2	3	4	5	6	7	8	9	10
Fixed Assets	**3,503**	**3,382**	**3,262**	**3,141**	**3,020**	**2,899**	**2,778**	**2,658**	**2,537**	**2,416**
Advance	-	-	-	-	-	-	-	-	-	-
Accounts Receivable	-	-	-	-	-	-	-	-	-	-
Debt Reserves	-	-	-	-	-	-	-	-	-	-
Cash	-	-	-	-	-	-	-	-	-	-
Total Current Assets	-	-	-	-	-	-	-	-	-	-
Total Assets	**3,503**	**3,382**	**3,262**	**3,141**	**3,020**	**2,899**	**2,778**	**2,658**	**2,537**	**2,416**
Accounts Payable	-	-	-	-	-	-	-	-	-	-
Working Capital	-	-	-	-	-	-	-	-	-	-
Debt Current Portion	202	222	243	267	293	322	353	388	426	-
Current Liabilities	**202**	**222**	**243**	**267**	**293**	**322**	**353**	**388**	**426**	-
Long-term Debt	2,514	2,292	2,049	1,782	1,489	1,167	814	426	-	-
Total Liabilities	**2,715**	**2,514**	**2,292**	**2,049**	**1,782**	**1,489**	**1,167**	**814**	**426**	-
Paid-up Capital	725	725	725	725	725	725	725	725	725	725
Retained Earnings	63	144	245	367	513	686	887	1,119	1,386	1,691
Total Equity	**788**	**869**	**970**	**1,092**	**1,238**	**1,411**	**1,612**	**1,844**	**2,111**	**2,416**
Equity & Liabilities	**3,503**	**3,382**	**3,262**	**3,141**	**3,020**	**2,899**	**2,778**	**2,658**	**2,537**	**2,416**

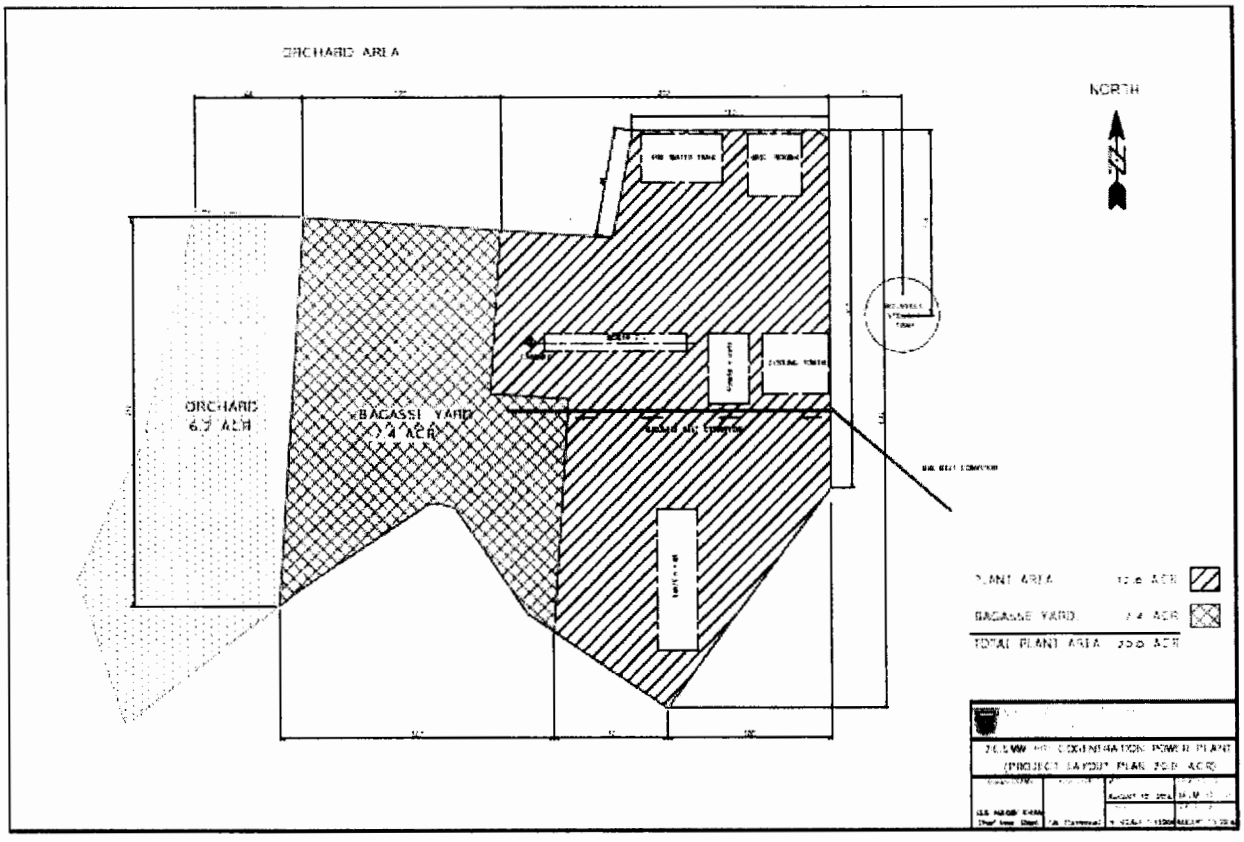
12.12 Projected Cash Flows

PKR millions	1	2	3	4	5	6	7	8	9	10
Earnings after tax	155	173	193	215	239	265	293	325	359	397
Add: Depreciation	121	121	121	121	121	121	121	121	121	121
Change in Advances	-	-	-	-	-	-	-	-	-	-
Change in A/C Receivable	-	-	-	-	-	-	-	-	-	-
Change in A/C Payable	-	-	-	-	-	-	-	-	-	-
Cash Flow from Operations	**276**	**294**	**314**	**336**	**359**	**385**	**414**	**446**	**480**	**518**
Cash Flow from Investment	-	-	-	-	-	-	-	-	-	-
Repayment of LT Debt	(184)	(202)	(222)	(243)	(267)	(293)	(322)	(353)	(388)	(426)
Repayment of WC Loan	-	-	-	-	-	-	-	-	-	-
Disbursement of Equity	-	-	-	-	-	-	-	-	-	-
Cash Flow from Financing	**(184)**	**(202)**	**(222)**	**(243)**	**(267)**	**(293)**	**(322)**	**(353)**	**(388)**	**(426)**
Net Cash Flow	**92**	**92**	**92**	**92**	**92**	**92**	**92**	**92**	**92**	**92**

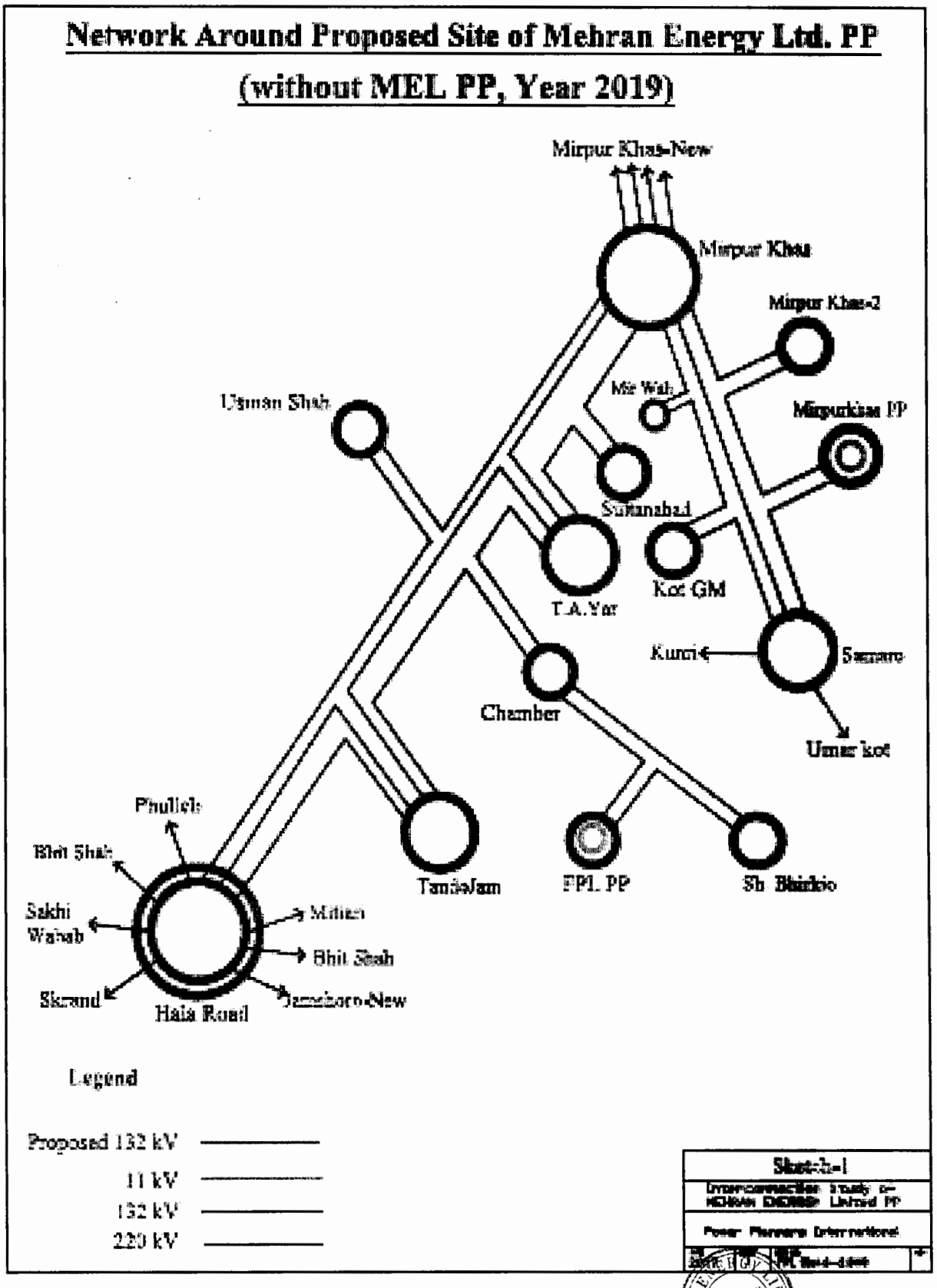
13 Financial Summary

	Min.	1	2	3	4	5	6	7	8	9	10
Revenue	**1,367**	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367
EBITDA	**566**	566	566	566	566	566	566	566	566	566	566
Net Income	**155**	155	173	193	215	239	265	293	325	359	397
Dividends	**92**	92	92	92	92	92	92	92	92	92	92
Annual Interest	**48**	289	271	252	230	206	180	151	120	85	48
Debt Servicing	**473**	473	473	473	473	473	473	473	473	473	47
Debt to Equity	-	3.45	2.89	2.36	1.88	1.44	1.06	0.72	0.44	0.20	-
Times Interest	**1.95**	1.95	2.08	2.25	2.46	2.74	3.14	3.73	4.71	6.62	11.90
DSCR	**1.20**	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Loan Life Cover Ratio	**1.15**	1.15	1.16	1.16	1.16	1.17	1.17	1.18	1.19	1.19	1.20

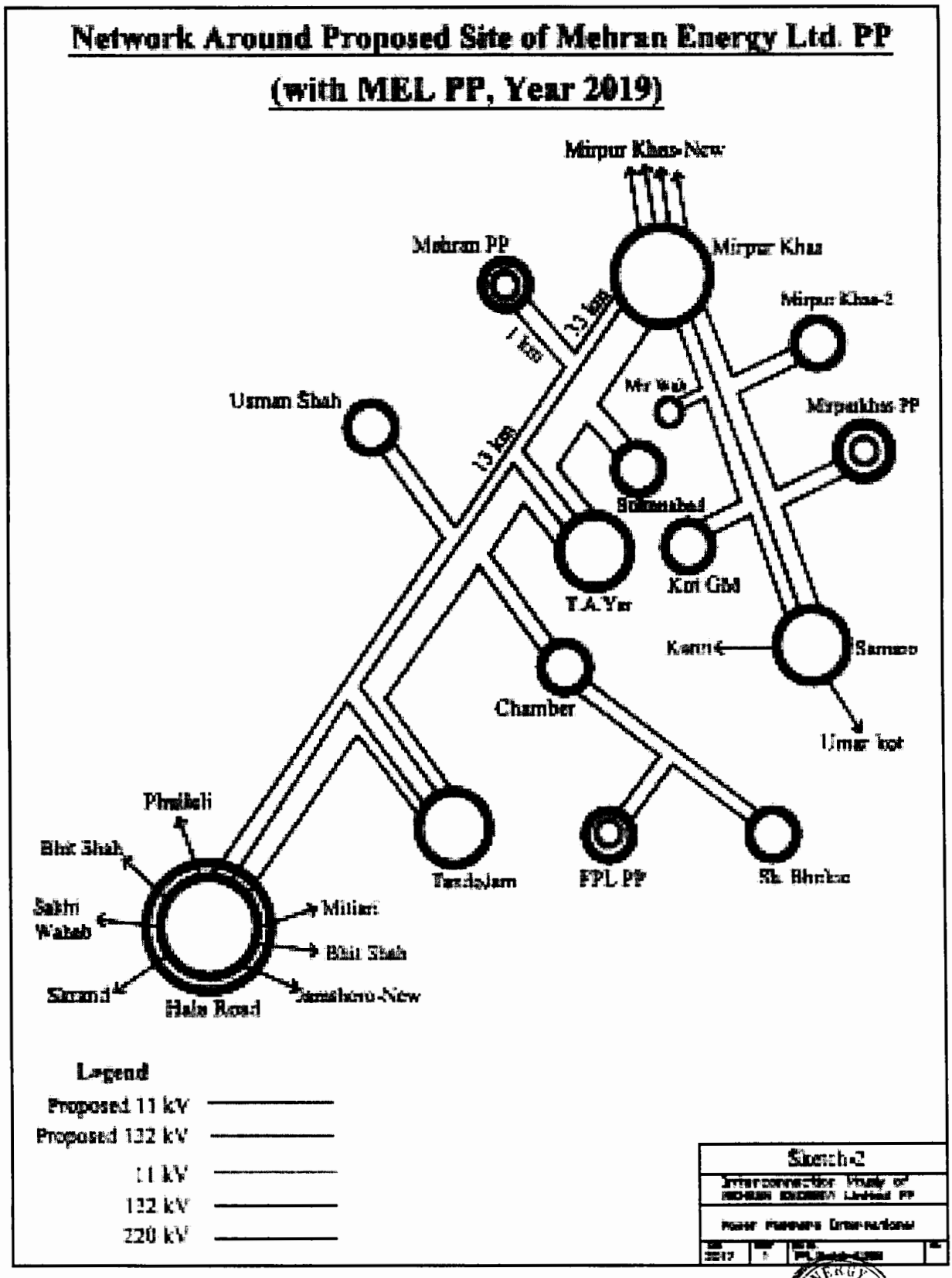
14 Annexure 1 – Plant Layout



15 Annexure-2 (Sketch 1)



16 Annexure – 3 (Sketch 2)



Prospectus

Introduction of Applicant

Mehran Sugar Mills Limited ("MSML"), through a wholly-owned subsidiary Mehran Energy Limited ("MEL"), intends to set up a green field 26.50 MW (Gross) high-pressure, bagasse based co-generation power plant (the "Project") under the provisions of the Framework for Power Cogeneration 2013 ("Framework") and Policy for Development of Renewable Energy for Power Generation 2006 ("RE Policy" or "Policy"). The Project will be located within the premises of MSML at Deh Daro Sutha, Tando Adam Road, Distt. Tando Allahyar, Sindh.

The Project will sell power to the national grid through sale of energy to the Central Power Purchasing Agency Guarantee Limited ("CPPA-G") under a 30-year Energy Purchase Agreement ("EPA"), as well as partially meet the steam and power requirements of MSML during the crushing season. The Project will enable MSML to establish a sustainable market for its by-product, bagasse, and will also allow the sponsors of MSML to take an exposure in the power sector through incentives offered by the Government of Pakistan ("GoP") under the Framework and RE Policy.

Salient features of the facility for which license is sought

The broad parameters of the project are as under:

Project Capacity	26.50 MW (Gross)
Project Location	Deh Daro Sutha, Tando Adam Road, Distt. Tando Allahyar, Sindh.
Land Area	20 Acre
Construction Period	20 months
Technology	Bagasse/Bio-Mass.
Power Purchaser	Central Power Purchasing Agency Guarantee Limited
Steam Turbines	1 X 26.50 M.W extraction cum condensing
Boilers	1 X 135 TPH, 110 Bar 540°C
Upfront Levelized Tariff	US Cents 10.62 per kWh

Proposed Investment

The total cost for the project is approximated PKR 3,623.98 Million (USD 33.19 million), which is expected to be financed in a debt to equity ratio of 80:20.

Social and Environmental Impact of the Proposed Facility

Bagasse based Cogeneration power plant, offers a number of advantages both to the sugar industry and to the country. Besides reducing gap between the demand and the supply in the power sector, Bagasse based fuel power cogeneration provides environmentally friendly solution for additional power generation, reduces dependence on fossil fuels, saves on hard earned foreign exchange from its outflow from the country for import of fossil fuels and gives sugar industry financial gains in the form of cheaper energy while using Bagasse as fuel.

Schedule III

General Information

(i)	Applicant's Name	Mehran Energy Limited
(ii)	Registered Office	Executive Tower, Dolmen City, 14-B, 14th Floor, Block-4, Marine Drive, Clifton, Karachi
(iii)	Plant Location	Deh Daro Sutha, Tando Adam Road, Distt. Tando Allahyar, Sindh
(iv)	Type of Generation Facility	Bagasse fired Cogeneration Power Plant
(v)	Commissioning/Commercial Operation Date	March 2019
(vi)	Expected Life of the Facility from Commercial Operation/Commissioning	30 years
(vii)	Expected Remaining Useful Life of the Facility	30 years

1. Location maps, site maps and land

- Site map attached as Annex-1
- The Project Site will be located within the premises of Mehran Sugar Mills Limited located at Deh Daro Sutha, Tando Adam Road, Distt. Tando Allahyar, Sindh. The total area of the sugar mill and its premises is 136.34 acres and of that, approximately 20 acres will be allocated to the construction of the power plant.

2. Technology, Size of Plant and Number of Units

(i)	Type of Technology	Cogeneration Power Plant with high pressure boilers and Turbo-Generators
(ii)	Installed Plant Capacity (Gross)	26.50 MW (Gross)
(iii)	Number of Units	One (01)
(iv)	Unit make, model & year of manufacture	2017
(vi)	Available Capacity	Power Generation: 25.98 MW (Season operation) 26.50 MW (Off-season operation)
(v)	Auxiliary Consumption	Approximately 9.0 %

3. Fuel: Type, Imported/Indigenous, Supplier, Logistics

(i)	Primary Fuel	Bagasse
(ii)	Alternate Fuel	NIL
(iii)	Fuel Source (Imported/Indigenous)	Indigenous

MEHRAN ENERGY LIMITED KARACHI

(iv)	Fuel Supplier	Mehran Sugar Mills Limited
(v)	Supply Arrangement	Through conveyor belts/loading trucks/tractor trolleys etc.,
(vi)	Sugarcane Crushing Capacity	542 TPH
(vii)	Bagasse Generation Capacity	158.80 TPH
(viii)	Bagasse Storage Capacity	Bulk Storage
(ix)	Number of Storage Tanks	Not Applicable, bagasse shall be stored in open yard

4. Emission Values

		Primary Fuel
(i)	SOx (mg/Nm^3)	361
(ii)	NOx (mg/Nm^3)	Less than 80 ppm
(iii)	CO^2	Nil
(iv)	CO (mg/Nm^3)	Nil
(v)	PM10(mg/Nm^3)	50

5. Cooling Water Source

(i)	Cooling Water Source/Cycle	RCC Counter Flow Cooling Tower of Capacity 6600 m^3/hr

6. Interconnection

(i)	Nearest Grid Facility	Existing 132 kV circuit between Mirpurkhas 132 kV Grid Station and Usman Shah 132 kV Grid Station
(ii)	Distance of Grid from Project Site	1 km
(iii)	Voltage Level	132 kV
(iv)	Single Line Diagram	Attached as Annex-2

7. Infrastructure

(i)	Road	Mehran Sugar Mills Limited is located at about 1.5 km in west of Tando Allahyar City on Tando Adam-Tando Allahyar Road. The main bypass of Tando Allahyar is about 800 yards from the main gate of the mills. The site is connected with all parts of Sindh through various link road and highways. From Tando Adam to Main Shahra-e-Pakistan and from Mirpurkhas dual carriage to Tharparkar which is border of India. From main Tando Allahyar highway it directly Linked with Karachi and Baluchistan.
(ii)	Rail	Hyderabad to Mirpurkhas (then up/down-country) railway track is passing 2 km away from the Project Site. Nearest railway stations is at Tando Allahyar. Whereas Mirpurkhas is 30 KM and Hyderabad is 35 KM away from the the Project Site.

(iii)	Staff Colony	The existing colony of Mehran sugar mills will be utilized by the staff of the Proposed Project. The colony is constructed over a 30 acres area and has all sort of facilities to the residents like Masjid, Madresa, playground, bungalows, labour housing colony, Workers' club, cricket ground, table tennis, tennis court, swimming pool, and other amenities. Safe filtered water, electricity, gas and generator facilities are also available for the residents.
(iv)	Amenities	School: One Government and One private school as MSM CSR project is situated in the colony. The fee structured is nominal and deserving students also given scholarships. Bus services from Colony / Mills to City: Free bus service from colony to city is available every day without any interval Medical facilities: A well-equipped dispensary with qualified Doctor and paramedical staff are available 24 hrs to meet any emergency to workers and staff.

8. Project Cost and Financing

Estimated Project Cost*	**PKR million**
EPC Cost	2,893.59
Non-EPC Cost	107.32
Project Development Costs	251.61
Insurance during Construction	28.94
Financing Fee & Charges	101.59
Interest during Construction (IDC)	240.93
Total	**3,623.98**
Debt	2,899.18
Equity	724.80

*Estimated projected cost is based on an average PKR/USD exchange rate of 109.19.

9. Project Commencement and Completion Schedule

Activity	**Duration**	**Start Date**	**End Date**
Issuance of LOI			7-Nov-16
EPC Activities	120	7-Nov-16	7-Mar-17
Grid Study, Approvals & CPPA-G Consent	140	7-Nov-16	27-Mar-17
Generation License Application & Approval from NEPRA	45	20-Mar-17	4-May-17
Tariff Application and Approval from NEPRA	30	27-Mar-17	26-Apr-17
Issuance of LOS	15	26-Apr-17	11-May-17
Signing of IA and EPA	60	11-May-17	10-Jul-17
Financial Close Activities	120	26-Apr-17	24-Aug-17
Construction Activities	600	24-Aug-17	16-Apr-19
Commercial Operations Date			16-Apr-19

MEHRAN ENERGY LIMITED KARACHI

10. Environment and Social Soundness Assessment

Report attached as Annex-3

11. Safety and Emergency Plans

Attached as Annex-4

12. System Studies, Load flow, Short circuit etc.

Detailed Interconnection and Grid Study has been submitted to HESCO for approval, attached as Annex-5.

13. Plant Characteristics

(i)	Generation Voltage	11,000 Volts	
(ii)	Frequency	50 Hz	
(iii)	Power Factor	0.8 (Lag) & 0.95 (Lead)	
(iv)	Automatic Generation Control (AFG)	Through Woodward Governor System	
(v)	Ramping Rate	Approximately 270 rpm	
(vi)	Time Required to Synchronize to Grid and Loading the Complex to Full Load from Cold Start	During cold start (i.e. when plant is started later than 72 hours after shutdown) During warm start (i.e. when plant is started at less than 36 hours after shutdown) During Hot start (i.e. when plant is started at less than 12 hours after shutdown)	a. Cold Start – 150 minutes b. Warm Start – 180 minutes c. Hot Start – 53 minutes

14. Control, Metering, Instrumentation and Protection

Attached as Annex-6.

15. Training and Development

The training and development program has been given due recognition so that safe and reliable operation and maintenance of the plant can be ensured. Training and Development programs have been devised to properly use various tools for training.

Apprenticeship Programs: One graduate and one skilled person will be absorbed in the plant for a period of one and half years in each of operation, electrical, instrumental and control, and mechanical department. He will be attached with assistant executive engineer level person. For skilled apprentice, the attachment will be with Foreman level person. Through such program the Plant will be serving the community as well as a database for company referral, when needed.

Training at Plant: Section wise training at plant on quarterly basis. The training to be imparted by senior plant management as well as by industry expert. The training to be imparted on two-tier basis; for lower management and middle management.

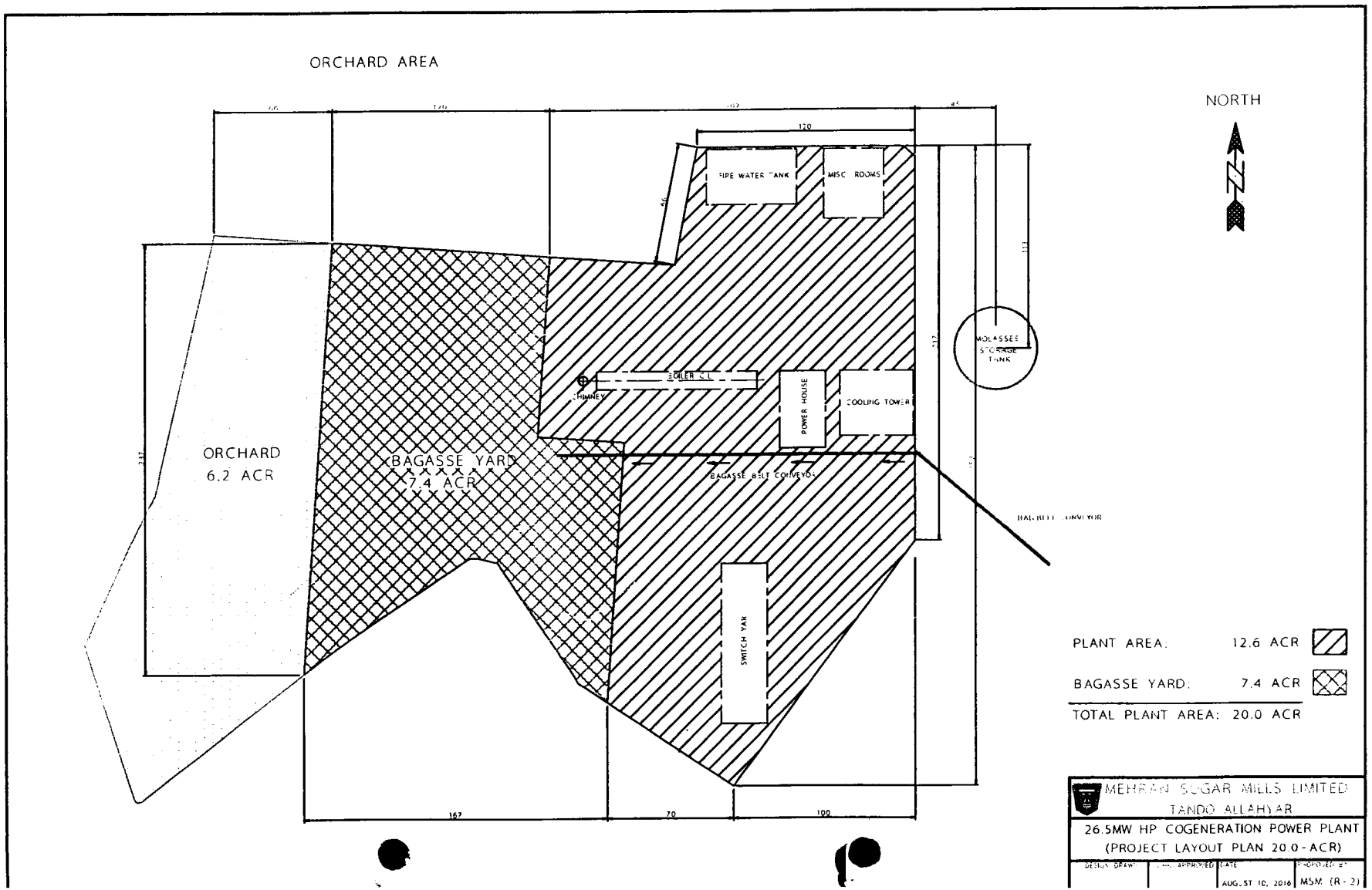
Training and Development abroad: The top tier to undertake management training and refresher on a six-monthly basis and to undergo foreign career development training every three months.

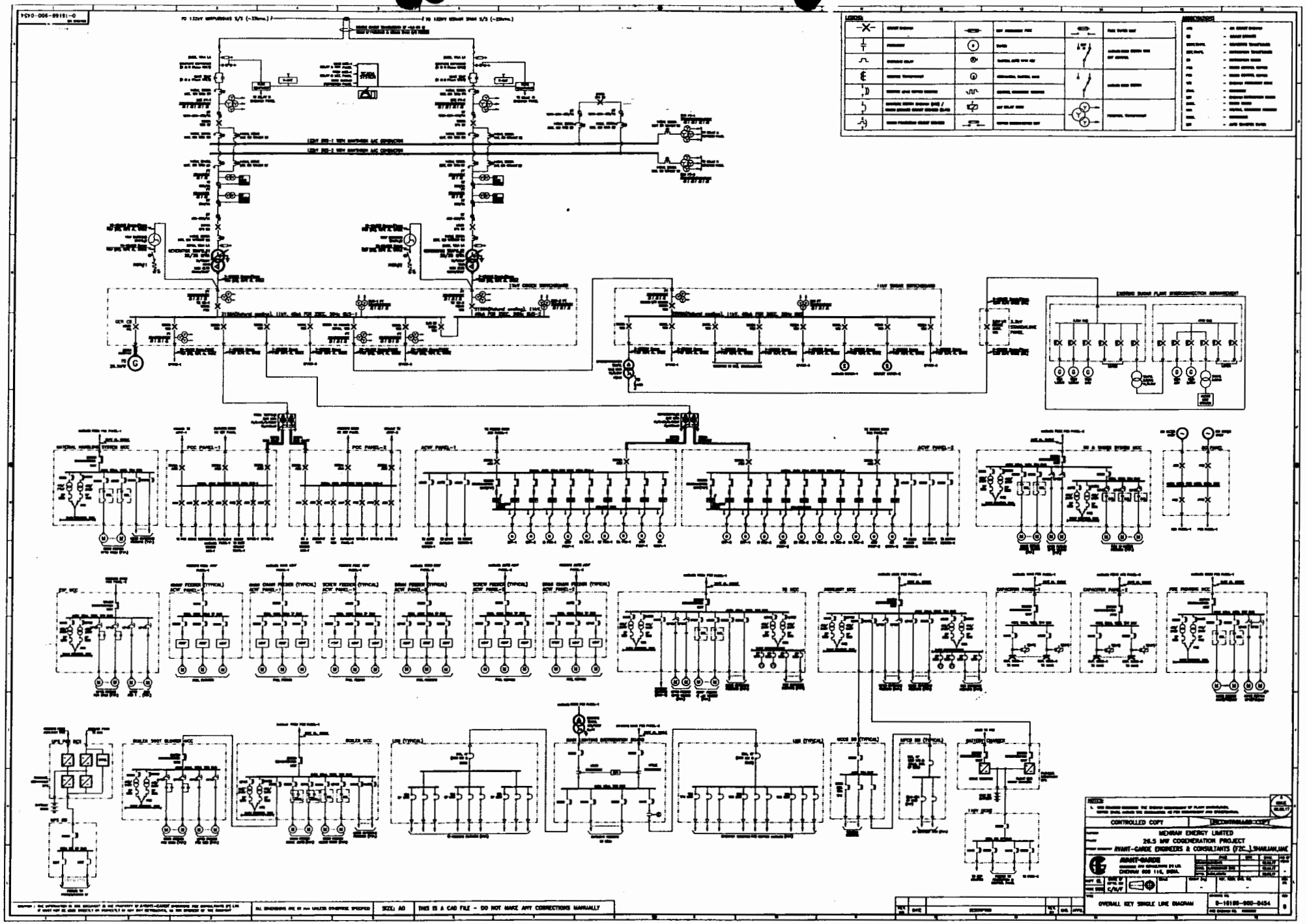
Operation and Maintenance Manuals: Referral to these manuals is a very good self-training and development tool. They are made by the experts of equipment and systems and are focused towards safe operation and corrective maintenance. They are very useful when consulted before and after the undertaking the work.

Visits and Trainings at Manufacturers' Works: Visits and trainings at outsourced maintenance firms is often a very good training source.

Working together with EPC Contractor: Each plant has certain unique features therefore the EPC contractor is often in the best position to operate and maintain. Entering into O&M agreement for an initial period of one or two years following project completion is a rich source of training and development of plant personnel.

Training and Development is an ongoing activity and the project Sponsors will devise the programs such that the benefits of various types of training are best attained.


ORCHARD AREA
NORTH
FIRE WATER TANK
MISC ROOMS
MOLASSES STORAGE TANK
BOILER C.L
CHIMNEY
POWER HOUSE
COOLING TOWER
ORCHARD
6.2 ACR
BAGASSE YARD
7.4 ACR
BAGASSE BELT CONVEYOR
SWITCH YAR
167
70
100
PLANT AREA: 12.6 ACR
BAGASSE YARD: 7.4 ACR
TOTAL PLANT AREA: 20.0 ACR
MEHRAN SUGAR MILLS LIMITED
TANDO ALLAHYAR
26.5MW HP COGENERATION POWER PLANT
(PROJECT LAYOUT PLAN 20.0 - ACR)
AUG. ST 10, 2016
MSM (R - 2)



CONTROLLED COPY

UNCONTROLLED COPY

MEHRAN ENERGY LIMITED

26.5 MW COGENERATION PROJECT

AVANT-GARDE ENGINEERS & CONSULTANTS (PVT.)

AVANT-GARDE

OVERALL KEY SINGLE LINE DIAGRAM

D-10105-000-0454

SIZE: A0

THIS IS A CAD FILE - DO NOT MAKE ANY CORRECTIONS MANUALLY

INITIAL ENVIRONMENTAL EXAMINATION

Mehran Energy Limited

Tando Allahyar, Sindh, Pakistan

Environmental
Total
Solutions

Initial Environmental Examination

Mehran Energy Limited

Tando Adam Rd., District Tando Allahyar, Sindh.
Phone # 92-0233-3890856 - 3890407

Environmental Total Solutions

Office No. 1, Aqsa Tower, Gulshan-e-Iqbal,
Main Rashid Minhas Rd., Karachi
Contact: 0333-2277350
Email: etspak1@gmail.com

SUSTAINABLE

ENERGY FOR ALL

Mehran Energy Limited
Head office: Executive Tower, Dolmen City, 14-B, 14th Floor, Block 4,
Marine Drive, Clifton, Karachi, 75600

EXECUTIVE SUMMARY

Mehran Energy Limited is proposing to construct a 26.5 MW bagasse driven power plant in district Tando Allahyar, Sindh in order to meet the increasing power demand in the region. The Company acquired approximately 15 acres of land neighboring the Mehran Sugar Mills Limited.

This Initial Environmental Examination (IEE) is to provide information on the potential negative and positive environmental and social impacts of the project. It also aims to make recommendations for the mitigation of the potential negative impacts and enhancement of the positive ones. A field survey of the project site was conducted and potential environmental impacts of project activities were identified, assessed, and documented.

Both the Pakistan and World Bank's social safeguard policies have been considered during the assessment. The Iee study has been carried out according to requirements of the current EIA/IEE Regulation of Sindh Government (Official Gazette, NO. PAS/Legis-B-06/2014) and the Sindh Environmental Assessment Policies and Procedures 2014

Aim of the IEE study is to meet the requirements of the Sindh EIA/IEE Legislation "Category A" Environmental Assessment Study (OP 4.01 Annex B Content of an EA Category A Report). For this purpose, EIA has been prepared according to the special EIA/IEE format regarding the requirements of the Sindh Environmental Protection Act 2014. The proposed project meets the requirements of the Sindh Environmental Protection Agency.

ABBREVIATIONS AND ACRONYMS

AAQ	Ambient Air Quality
ADB	Asian Development Bank
BOD	Biochemical Oxygen Demand
CHP	Combined heat and power
CWDS	Circulating Water Discharge System
CO_2	Carbon dioxide
CH_4	Methane
DO	Dissolved Oxygen
EAF	Equivalent Availability Factor
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EMS	Environmental Management Staff
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
HSE	Health, Safety and Environment
HESCO	Hyderabad Electric Supple Company
HGVs	Heavy Goods Vehicles.
IPP	Independent Power Producer
ISG	Integrated Steam Generator
IUCN	International Union for Conservation and Natural Resources
SEQS	Sindh Environmental Quality Standards
NTDC	National Transmission and Dispatch Company
NOC	No Objection Certificate
NO_X	Oxide of Nitrogen
O_3	Ozone
PEPA	Pakistan Environmental Protection Agency
PEPCO	Pakistan Electric Power Company
PEPC	Pakistan Environmental Protection Council
PM_{10}	Particulate Matter ($10\mu gm^3$ size)
$PM_{2.5}$	Particulate Matter ($2.5\mu gm^3$ size)
SS	Suspended Solids
STG	Steam Turbine Generator

SDPI	Sustainable Development Policy Institute
SO_2	Sulfur dioxide
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
WHRB	Waste heat recovery boilers
WWF	Worldwide Fund

UNITS

dB(A)	Decibel (A-rated)
Ft	feet
Ft^2	Square foot
ha	Hectare (1 hectare = 2.47 acres)
Km	Kilometer
Km^2	Square Kilometer
Km/h	Kilometer per hour
KWh	Kilo Watt per hour
^0C	Degree Celsius
MGD	Million Gallons per Day
MT	Metric Ton
MW	Mega-Watt (One million watt)
MWe	Mega-Watt electrical
mg/Nm^3	Micro gram per normal cubic meter
mph	Miles per hour
m_2	Meter Square
m^3	Cubic meter
Nm^3/h	Normal cubic meter per hour
Sq. Km	Square Kilometer
TPD	Tones per Day

TERMS USED IN POWER GENERATION

Abatement	Effort to avoid emission of Carbon Dioxide
Barring	The process of slowly turning the Turbine-Generator shaft to prevent bowing while it is still hot after shutdown
Biomass	Living or recently dead material such as plant matter, used as either fuel or industrial production as bio-fuel
Clean Fuel	Fuel that has been modified such that, on combustion, it produces lower emissions
Co-generation	A particularly efficient method of electricity generation that diverts heat produced as a by-product of the power generation process, to domestic and industrial heating systems.
Combined cycle power plant:	Conventional thermal power stations produce steam to drive turbines that generate electricity. In a combined cycle plant, two turbines are used. The first is driven by oil or gas, and waste heat from that process contributes to the production of steam to drive the second turbine
Emissions	The release or discharge of substances, effluents or pollutants into the environment
Feeder	Over head lines that are used to distribute electrical power to consumers. Feeders connect distribution substations and consumers.
Generator	A device that converts rotating mechanical movement into electric power
Greenfield	A new field development requiring new facilities, either onshore or offshore
Heat Rate	The amount of fuel energy required to produce electrical energy
Load	A load in electrical terms is the power consumed by a device or a circuit. Load is also used to describe the total of all electricity consumers in a power system.
Power factor	Power factor is the ratio of real power to reactive power in an electric circuit and a measure of whether the system's voltage and current are "in phase."
Turbine	A propeller-like device that is turned by a stream of hot gas (steam in a conventional thermal power station), water (in a hydro plant), gas (in a gas power plant:
Water Injection	The process where water is injected back into the oil reservoir to maintain or increase pressure and stimulate production.

TABLE OF CONTENTS

Chapter 1

INTRODUCTION

1.1 OVERVIEW

This report presents the findings of Initial Environmental Examination (IEE) study carried out by Environmental Total Solutions (ETS) for the proposed bagasse based cogeneration power plant being undertaken at Mehran Energy Ltd., located at Tando Adam Rd., District Tando Allahyar, Sindh, Pakistan, Sindh.

The IEE has been prepared in compliance with the requirements of Sindh Environmental Protection Act (SEPA) 2014, Sindh Environmental Assessment Procedures, 2014 and Pakistan Environmental Protection Agency (Review of EIA/IEE) Regulations-2000. Compliance with the Provisions of SEPA 2014, Section-17(1) required that:

"No proponent of a project shall commence construction or operation unless he has filed with the Agency an initial environmental examination or environmental impact assessment, and has obtained from the Agency approval in respect thereof."

1.2 NATURE AND SIZE OF THE PROJECT

M/S Mehran Energy Limited is planning to install a bagasse based co-generation power plant having condensing and extraction steam turbine with ahigh-pressure boiler, at Tando Allahyar, in the province of Sindh, will be installed close tothe already operational Mehran Sugar Mills Limited at Tando Adam Rd., District Tando Allahyar, Sindh, Pakistan. The project will use the sugar mill's by-product, bagasse, as fuelsource which is not only economically supportive but also environmentally friendly at the same time. Bagasse would be available to the power plant without any interruption and without incurring any extra expenditure on the transportation of bagasse. Steam condensate from adjacent MSML will be returned to power plant.

Location

The power plant is designed to run on bagasse to cater for the reliable and economic power to the sugar plant as well as the national grid to help mitigate the chronic power shortage in the country and also to meet the power and process steam demand of the MSML. Due to this reason, the power plant has to be sited close to the Sugar Mill to satisfy both requirements as well as the return of steam condensate from Sugar Mill.

1.3 IMPORTANCE & BACKGROUND OF THE PROJECT

Despite severe challenges, the economy has shown resilience in the outgoing year. The Gross Domestic Product (GDP) in Pakistan expanded 4.24 percent in 2015 from the previous year. GDP Growth Rate in

Pakistan averaged 4.91 percent. The economy has been growing at an average rate of 3.59% over the past five years ending June 2015. According to the Economic Survey of Pakistan, 2015-16, "the longer term prospects for the economy are promising, given potential drivers such as the size and dynamism of the Pakistani diasporas, the potential for unleashing large productivity gains in agriculture, improvements in the economic environment by a deepening of regional trade and investment links, and the harnessing of the 'youth bulge'". The expected growth objective will need a commensurate rise in energy use.

Considering the strong correlation between economic growth and energy demand growth, there is an imperative need for sustained increase in energy supply not only to sustain the growth momentum but also to protect the economy from disruptions caused by energy deficits reflected in demand management, popularly known as load shedding.

The demand and supply of electricity was balanced in 1997 with the commissioning of private sector Independent Power Producers (IPPs) established under the Private Power Policy of 1994. Generation capacity has increased since 1997, and it was expected that demand and supply would remain in equilibrium through 2009.

However, faster economic activity, rising disposable income, higher availability of consumer finance, double-digit growth of large-scale manufacturing, and higher agricultural production have all resulted in higher demand for power. As peak demand growth approached 6.6% per year during 2001 to 2007, the supply shortage occurred much earlier than 2009.

With double digit growth of large scale manufacturing in Pakistan, it has resulted in higher demand for power in the country. As a result of serious power shortages, load shedding are frequent in Pakistan. The gap between power supply and demand is further on the increase. Consequently, all walks of life are being adversely affected.

To sustain growth, Pakistan needs an integrated National Energy Plan. The Government of Pakistan (GOP) is making concerted efforts to ensure development of energy resources. The government has encouraged the private sector to meet this additional demand. In order to bridge the gap between power demand and supply, Pakistan Government liberalized its investment policies. The policy has resulted in investments in the power generation sector from both local and foreign sources.

Pakistan is energy deficit country. Fossil fuels are already in short supply, and the available ones are festally depleting. On the other hand, their industrial use is fast on the increase. In order to meet the present day requirements of the fuels and to fulfill the future increased demand, alternate fuels have to be inducted on a priority basis.

With increasingly more disparity between energy supply and demand, and keener attention of the Government to environmental protection, use of non-conventional energy resources such as bagasse as primary fuel for power generation has been favored in government's policies. The GOP has recently

announced a Co-Gen Power Policy for sugar mills to generate power using bagasse more efficiently. Bagasse is currently being used in the sugar industry in an uneconomical way for producing heat and power in low-pressure boilers.

In line with Co-Gen Policy 2008, MEL is planning to install a Co-generation power plant with bagasse as fuel near Tando Adam Rd., District Tando Allahyar, Sindh. According to the project feasibility report, Pakistan has an installed electricity generating capacity of about 19,400 MW. Projection for the demand in year 2030 is forecast to be 100,000 MW. The Government of Pakistan has recognized that bagasse-based cogeneration power plants can play a significant role in augmenting the country's power generation capacity.

They are also environmental friendly and are indigenous source of raw material which is derived from our agriculture. Also the project is in rural Pakistan where energy is directly required. It is in close proximity to the national grid. Accordingly, the "National Policy for Power cogeneration by Sugar Industry" was promulgated in January, 2008. It is estimated that Pakistan has a potential of generating more than 3000 MW of electricity through Cogeneration from its existing sugar industry.

1.4 PROJECT OBJECTIVES

The project aims to produce electricity for supply to NTDC / HESCO through national grid thus reducing the supply and demand imbalance. The proposed power plant is a standalone power producing unit based on cogeneration fired Boilers along with T.G. Sets.

The main objectives of the Project are:

- Respond to the urgent need to close the widening gap between power generation and demand. Ensure stable power supply to NTDC / HESCO.
- Provide employment to the local people;
- Respond to the need of improvement in quality of life through sustainable power production systems.

Project Benefits

The major benefit of this project is that it would generate many facilities in the region such as communication, employment and transport. It will also benefit the district by the development of the rural area. The major share of the district income is from the agriculture sector. Agriculture resources can be used for conversion into value added products.

Compliance of ToR

The EIA report is prepared based on the primary data and data collected from secondary sources. The issues given in the ToR of EPA, Sindh is fully addressed and point-wise compliances are given in the report.

1.5 INITIAL ENVIRONMENTAL EXAMINATION (IEE)

The objectives of the study is preparation of Initial Environmental Examination Report based on the EIA notification of 2014 of Sindh Environment Protection Act and requirement of concerned regulatory agencies of the State Government, incorporating the study on existing environmental conditions and various environmental issues due to proposed project.

- Assessment of the present status of air, noise, water, land, ecology and socio-economic components of the environment in the study area of the project.
- Identification, quantification, prediction and evaluation of significant impacts of the proposed project on various environmental components during the pre-project stage, construction stage and also after commissioning of the proposed project using mathematical/simulation models.
- Evaluation of the proposed waste disposal scheme for the aforementioned project.
- Identification of forestland, agricultural land, wasteland, water bodies etc. around the area
- Evaluation of the existing Environmental Management Plan (EMP) and preparation of mitigation of anticipated adverse impacts.
- Delineation of the post project environmental quality-monitoring program to be pursued by Reliance Industries Limited, as per the requirements of the EPA.

1.6 JUSTIFICATION ON REQUIREMENT OF IEE

The Pakistan Environmental Protection Agency (Review of EIA/IEE) Regulations 2014 clearly define the categories of projects requiring an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) in Schedules I and II respectively.

A proponent of a project falling in any category listed in Schedule-I shall file an IEE with the Agency, and the provisions of section 17 shall apply to such projects, as per Para 3 of EIA / IEE regulations-2014.

Power plants generating less than 200MW electricity are placed in Category B (Energy) of Schedule I (List of projects requiring of IEE). In consideration of:

- Low sensitivity of the microenvironment in which the no unit is being sited,
- Impact of different activities including construction, installation, commissioning and operation being confined to and localized into the microenvironment and
- Compliance with the above cited regulations,

The project would be placed in Category B, Schedule I, requiring an IEE study. Accordingly an IEE study has been conducted and the report will be submitted to Sindh EPA for review and approval.

Scope of the IEE

The purpose of this IEE study is identification of key environmental and social issues which will likely arise during construction and operation of the power plant along with the assessment of the significant negative impacts and mitigation measures to be adopted for their minimization. The ultimate goal of this IEE report is to produce an Environmental Management Plan (EMP) and Environmental Monitoring Plan

(EMtP) for the Construction and Operation Stages of the proposed project. Compliance with the guidance contained in these plans will ensure the implementation of this project in an environmentally sustainable manner both at Construction as well as Operation stages of the Project.

The IEE report ensures compliance to all national and local regulations enforced in Pakistan as well as the Sindh Environmental Protection Act 2014 Guidelines for such reports. However, taking into consideration the international requirements, due attention has also been given to Equator Principles (EPs) and the International Finance Corporation (IFC) Performance Standards on Social and Environmental.

This EIA report also discusses the legal and administrative framework within which the EIA/IEE is prepared. A brief project description is included together with a description of the baseline environmental conditions and the actual environmental situation at the proposed site for the project. The technical section of the report and the environmental baseline situation form the basis for the detailed impact assessment during the construction and operation phases of the project. Based on the findings of this report, an environmental management system has been devised, outlining necessary mitigation and compensation measures together with monitoring practices.

1.7 METHODOLOGY FOR IEE

Review of Legislation and Guidelines

National Legislation, International agreements, environmental guidelines, and best industry practices were reviewed. It included previous environmental studies and environmental baselines conducted by ETS and associated consultants in the past in the project area and / or its surroundings. All data sources were carefully reviewed to collect project area's related information with regard to physical, biological and socio-economic environment

Field Data Collection

During the site visit, primary data and information on the physical, biological and socio-economic background conditions of the microenvironment and macro environment of project area was collected area specific primary information along with their views and concerns regarding the project activities.

Anticipated Environmental Impacts and Mitigation Measures

- Environmental parameters have been identified assessed and used for identification, prediction and evaluation of significant impacts.
- For impact on land and biological components of environment, the predictions have been made based on available scientific knowledge and judgment.

Recommendations

A number of mitigation measures are recommended against the adverse activities during the construction and operation phases of the project. Measures recommended during the construction phase include control of noise pollutions from heavy equipment and vehicles through proper inspection and maintenance, and

use of noise suppressors or mufflers for heavy equipment, control of air pollution from construction works and movement of vehicles through proper inspection and maintenance to reduce exhaust emissions, watering of unpaved roads, control of adverse impacts from construction debris by proper handling and immediate removal, control of water pollution through proper storage and handling of oil wastes and treatment of wastewaters at site, control of solid wastes through sanitary storage and frequent collection for sanitary disposal.

Quality of air and water will be monitored on a regular basis where noise will be measured periodically. Oil wastes will be treated with employing proper handling and storage of oils/oil wastes and stringent management of oil spills, all of which will be assured with periodic monitoring of noise and emission levels and drinking water quality. All precautions against fire accidents and electrocution will also be taken.

In all phases occupational health and safety will be carefully considered and controlled through continuous inspection to prevent disease and accidents, and workers will undergo an environmental and safety briefing on safety, sanitation measures, and emergency rescue procedures before development begins. Adequate sanitary facilities, potable water, and garbage bins will be provided. From the study findings, it has been concluded that the impacts of the proposed project are minor and easily mitigable. The developer is strongly advised to implement the recommendations made by the IEE Team.

Recommendations to Mitigate Impacts

Keepings impacts which may arise from project related activities were identified; mitigation measures were recommended to minimize, eliminate, or compensate for the potential environmental and social impacts on the zone of influence of the Project. Mitigation measures were recommended on the basis of past experience, best industry practices, legislative requirements and professional judgment.

Environmental Quality Monitoring in the Study Area

Air Quality

The air quality status in the study area is assessed through a network of ambient air quality monitoring locations. The baseline studies for air environment include identification of site and project specific air pollutants prior to implementation of the project.

- Ambient Air Quality Monitoring (AAQM) was carried out at pre-identified locations. Numbers of sampling locations were selected close to the plant site and in the downwind direction.
- Ambient air quality was carried out as per SEPA guidelines to determine a finer cross-sectional distribution of air pollution in an industrial developed region. The conventional air parameters viz. SO_2, NO_x, PM_{10}, $PM_{2.5}$ was monitored.
- The concentrations have been compared with stipulated standards of SEQS (as per the National Ambient Air Quality Standards Notification,

- Micro-meteorological parameters such as wind speed, wind direction, temperature and humidity were reported including wind direction in the study area. The data were used to determine predominant meteorological conditions, characterizing baseline status and in prediction of impacts on air environment.

Noise Environment

- Noise standards have been designated for different types of land use, i.e. residential, commercial, industrial areas and silence zones, as per 'The Noise Pollution (Regulation and Control) Rules, 2000, Notified by Ministry of Environmental protection, Government of Pakistan. The ambient noise standards and safe noise exposure limits are presented as Annexure. Different standards have been stipulated during day time (6 am to 10 pm) and night time (10 pm to 6am).
- The residential, commercial, industrial areas and silence zones close to the project site and in the study area have been identified. These locations have been chosen away from the major roads and major noise sources so as to measure ambient noise levels. Noise level measurements were carried out around the proposed plant site. Spot noise levels (A - weighted) were measured using a portable noise level meter.

Water Environment

Surface and groundwater quality has been determined and compared with Drinking Water Standards.

- The parameters of prime importance under physical, chemical (inorganic and organic), and nutrient and heavy metals category were selected.
- The water requirement and water availability in the region will be determined using secondary sources. Water balance in term of water input and output has been computed. The proposed project will have water requirement in terms of DM and cooling water only.

Land Environment

Field surveys were conducted to delineate classification of land-use pattern around the plant site.

1.8 ECOLOGY

Flora

- A team of botanists including biologists identify the plants in the study area through visual observation and recording the plant species as a list in the region. This list will be confirmed by the review of site literature. The data available with various agencies is referred for identifying rare or endangered species in the region.
- The ground area covered by aerial portion of the flora is called its "cover" and is used as a measure of plant's importance. The diameter of tree trunk at breast height (4.5 ft or 135 cm) is used as an expression of cover or dominance. The phyto-sociological data available for the study area are included in the report.

- Qualitatively, flora is assessed by delineating the type, its habitat, unique vegetative features, interrelations or associations with other community members. Plants are also observed for morphological aberrations, if any, due to pollution or any other stress. Plant species are rated visually based on its foliar cover and abundance.

Fauna

A total of 27 birds species were recorded during the survey through direct sighting or information from locals and Wildlife experts/ staff deployed in the area. During discussions with locals and Sindh Wildlife Department's staff, it was noted that populations of certain bird's species are declining due to human's disturbances particularly due to hunting activities which affect the population of Black partridge

Socio-economic Environment

- Data on the demographic pattern, population density per hectare, educational facilities, agriculture, income, fuel, medical facilities, health status, transport, recreational and drinking water facilities were collected from secondary sources and field visits and analyzed.
- The information on industries, infrastructure facilities such as power supply, water supply, telecommunication, sewerage etc. and transportation such as roads, harbors, railway, airports and navigation were collected from secondary sources and field visits

Environmental Management Plan

- Environmental Management Plan (EMP) is drawn after identifying, predicting and evaluating the significant impacts on each component of the environment with a view to maximizing the benefits from the project. Post-project.
- Environmental Monitoring programme is also delineated in the report.
- Thus, the report has been prepared in accordance with the guidelines of EPA, Sindh as amended from time to time and with the scope of studies given in ToR issued by EPA, Sindh.

Reporting

In the end, all activities / steps performed during IEE study were documented in shape of IEE report; it was compiled in the format / guideline given by Pakistan Environmental Protection Agency (PEPA) in Pakistan Environmental Assessment Procedures, 1997.

1.9 THE PROPOSED PROJECT

The objective of the project is to satisfy the ever increasing demand for electricity in Pakistan with a clean alternative to the more fossil-fuel based electricity component of the Pakistan national grid. The project aims to generate net 23.65 MW of electricity during crushing season and 24.25 MW electricity during off season to export to the national grid. The project is to be located at Tando Adam Rd., District Tando Allahyar, Sindh, Pakistan, Sindh, next to Mehran Sugar Mills,

The proposed Clean Development Mechanism (CDM) project, the Mehran Power Cogeneration Project, is a power project involving the generation of electricity using sugarcane bagasse on site.

The area available for the Mehran Energy Limited is given below:

Total Plant Area: 15 Acres

Process Description

Requirement of the steam and power for process plants will be met by installing high pressure boilers of suitable capacity. The concept of total energy envisages production of one of the requirements e.g. steam as main condition while power generation follows.

The steam demand is proposed to be met by high pressure bagasse fired boiler having a capacity of 140 TPH. Steam parameters at super heater outlet will be maintained at 110Bar atm., 550°C in conformity with the steam pressure existing in the present steam system. The power would be produced in steam turbine generators.

The BCPP equipments comprises balanced draft type CFBC boilers, meeting the steam generation parameters within subcritical

1.10 PROJECT SALIENT FEATURES

1. Project Name	Mehran Energy Ltd.
2. Project Location	Tando Adam Rd., District Tando Allahyar, Sindh, Pakistan, Sindh
3. Project Design Parameters	As attached

Plant Configuration	**Season**	**Off Season**
a. Net Capacity	23.65 MW	24.25 MW
b. Parasitic Load	2,339 KW	2,252.5 KW
c. In House Consumption	3,053 KW	500 KW
d. Load Available for HESCO	21,108 KW	23,747.5 KW
e. Type of Technology	Steam Turbines	(Condensing & Extraction)
f. Number of Generator	01 Set	01 set
g. Capacity of each generator	26.5 MW	26.5 MW
h. Gross Capacity	26.5 MW	26.5 MW

Fuel Used

a. Fuel Type	Bagasse
b. Fuel (Imported / Indigenous)	LOCAL
c. Fuel Supply (Bagasse)	Mehran Sugar Mills & Other Sugar Mills

Water

Cooling Water Source	Ground Water / local canals

Grid Station

Name of Grid Station	T-20 (Tando Mohammad Khan Road)
Distance	02 km

1.11 STRUCTURE OF REPORT

This report reviews information on existing environmental attributes of the areas around the Study Area. Geological, hydrological and ecological features, air quality, noise, water quality, soils, social and economic aspects and cultural resources are included. The report predicts the probable impacts on the environment due to the proposed project enhancement and expansion. This IEE also proposes various environmental management measures. Details of all background environmental quality, environmental impact/pollutant generating activities, pollution sources, pollution control equipment, predicted environmental quality and related aspects have been provided in this report.

The report is organized in following chapters

Chapter 1 Introduction

Containing general information about the project and process of carrying out the study

Chapter 2: Legislative and Regulatory Aspects

This chapter discusses the policy, legal, and administrative framework within which the IEE is carried out.

Chapter 3: Description of the Environment

This chapter of the IEE presents the results of an assessment of the dimensions of the study area and describes relevant physical, biological, and socioeconomic conditions, including any changes anticipated before the project commences. The assessment takes into account the current and proposed development activities within the project area but not directly connected to the project.

Chapter 4: Review of Alternatives

This chapter deals with systematically compare feasible alternatives to the proposed project site, technology, design, and operation—including the "without project" situation—in terms of their potential environmental impacts.

Chapter 5: Analysis of Environmental Impacts

The likely positive and negative impacts of the proposed project are identified and quantified to the extent possible. The section also includes information on mitigation measures to be taken during construction and operation of the facility and any residual negative impacts that cannot be mitigated. In addition, the chapter identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions.

Chapter 6: Environmental Management Plan

The project's environmental management plan (EMP) consists of the set of mitigation, monitoring, and institutional measures to be taken during implementation and operation to eliminate adverse

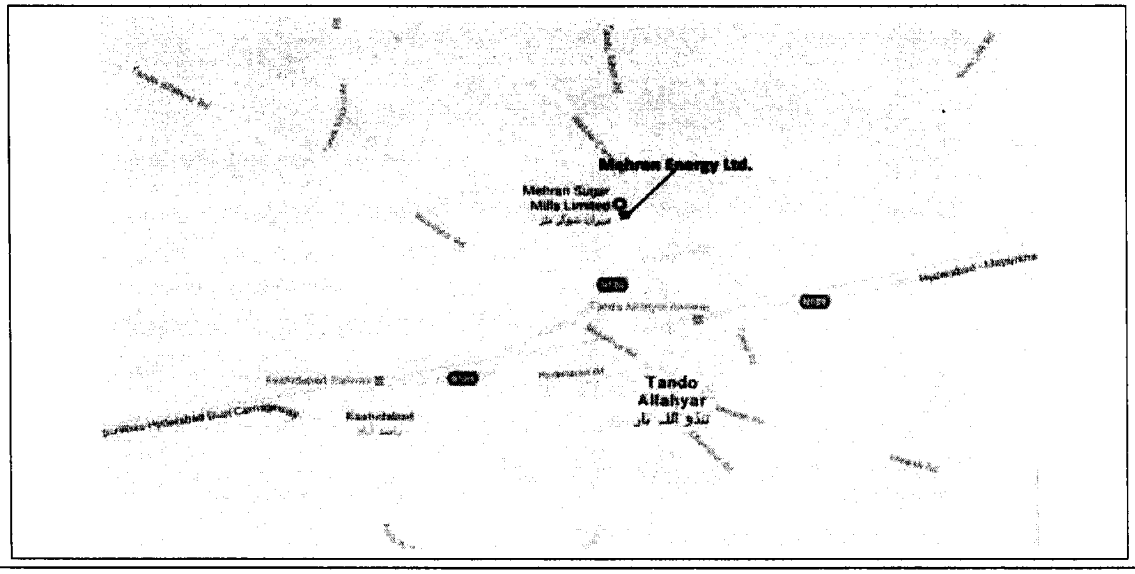
environmental and social impacts, offset them, or reduce them to acceptable levels. The plan also includes the actions needed to implement these measures.

Chapter 8: Conclusion

PROPONENT DETAILS

Contact Person	Ikhlas Ahmed Khan Cell: 0321-8281387 Email: ikhlas.ahmad@mehransugar.com
Registered Office	Executive Tower, Dolmen City, 14-B, 14th Floor, Block 4, Marine Drive, Clifton, Karachi, 75600 Phone # 92-21-35297814-17 Fax: 92-21-35297818
Location of Mills	Tando Adam Rd., District Tando Allahyar, Sindh. Phone # 92-0233-3890856 - 3890407 Fax: 92-0233-3890568-3891984 Phone # 92-0233-3890856 – 3890407
Email **Website:**	ikhlas.ahmad@mehransugar.com http://www.mehransugar.com
Year of Establishment	2016
Type of Industry	Energy Cogeneration power plant
Environmental Consultant	Environmental Total Solutions (ETS)
	Office No. 1, Aqsa Tower, Main Rashid Minhas Rd., Karachi.
	Contact: 0333-2277350
	Email: Etspk41@yahoo.com, iqbalh41@yahoo.com

LOCATION MAP OF MEHRAN SUGAR MILLS LTD



Chapter 2

LEGISLATIVE & REGULATORY ASPECT

2.1 PREFACE

The EIA/IEE of the proposed project will be subjected to the pertinent legislative and regulatory requirements of the Government of Pakistan including provincial laws. The success of environmental assessment is a mean of ensuring that development projects are environmentally sound and sustainable depending upon the capability of regulatory institutions for environmental management. The institutional framework for decision-making and policy formulation in environmental and conservation issues is briefly described below. However it is important to note that department such as Department of Environment, Climate change and Coastal Development, Forest and Wildlife department are newly formed departments of Government of Sindh and SEPA (Sindh Environmental Protection Agency) operated under these departments.

SEPA is basically monitoring and regulating agency with the following functions:

- Enforcement of NEQS and now enforcement of SEQS from 2014
- Review of EIAs and IEEs
- Implementation of Self-Monitoring and Reporting Tool (SMART)
- Coordination of pollution prevention and abatement measures between
- Providing advice to the government on issues related to environment
- Assistance to provincial and local governments in implementation of schemes for proper disposal of wastes to ensure compliance with SEQS
- Undertake measures to enhance awareness on environment among general public Conduct research and studies on different environmental issues
- Carry out any other task related to environment assigned by the government.
- Attend to public complaints on environmental issues.

It is important to note that SEPA will be responsible for the review and approval of EIA/IEE of the proposed project. This chapter of the report presents a synopsis of environmental policies, legislation and other guidelines which are described below that have relevance to the proposed project.

2.2 NATIONAL ENVIRONMENTAL POLICY, LEGISLATION AND GUIDELINES

The enactment of comprehensive legislation on the environment, covering multiple areas of concern, is a relatively new and ongoing phenomenon in Pakistan. Whereas, a basic policy and legislative

framework for the protection of the environment and overall biodiversity in the country is now in place, detailed rules, regulations and guidelines required for the implementation of the policies and enforcement of legislation are still in various stages of formulation and discussion. The following section presents a brief overview of the existing national policies, legislation and guidelines.

National Conservation Strategy (NCS)

The National Conservation Strategy (NCS) is the primary Policy document of the Government of Pakistan on national environmental issues. The Policy was approved by the Federal Cabinet in March 1992. The Strategy also attained recognition by international donor agencies, principally the World Bank. The NCS identifies 14 core areas including conservation of biodiversity, pollution prevention and abatement, soil and water conservation and preservation of cultural heritage and recommends immediate attention to these core areas in order to preserve the country's environment.

A midterm review of the achievements of NCS in 2000 concluded that achievements under NCS have been primarily awareness raising and institutional building rather than actual improvement to environment and natural resources and that NCS was not designed and is not adequately focused as a national sustainable development strategy (Arthur J. Hanson et al, Pakistan's National Conservation Strategy Renewing Commitment to Action, Report of the Mid-Term Review, 20001). The need therefore arose for a more focused National Environmental Action Plan (NEAP) required to bring about actual improvements in the state of the national environment with greater emphasis on poverty reduction and economic development in addition to environmental sustainability.

The National Environmental Action Plan was approved by the Pakistan Environmental Protection Council under the chairmanship of the President/Chief Executive of Pakistan in February 2001. NEAP now constitutes the national environmental agenda and its core objective is to initiate actions that safeguard public health, promote sustainable livelihoods, and enhance the quality of life for the people of Pakistan.

A National Environmental Policy has been approved by the Federal Cabinet in its meeting held during June 2005 (National Environmental Policy, GoP, 2005). This policy has already been endorsed by the Pakistan Environmental Protection Council during 2004. The new policy has total 171 guidelines on sectoral and cross-sectoral issues. The objectives of new policy include assurance of sustainable development and safeguard of the natural wealth of country. The following are the approved Sectoral Guidelines;

- Multilateral Environmental Agreements
- Agriculture and Livestock;

- Energy Efficiency and Renewable;
- Climate Change and Ozone Depletion;
- Biodiversity and Protected Areas;
- Forestry;
- Waste Management;
- Air Quality and Noise;
- Water Supply and Management;

2.3 SINDH ENVIRONMENTAL PROTECTION ACT 2014

The Sindh Environmental Protection Act, 2014 (SEPA 2014) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The SEPA 2014 is broadly applicable to air, water, soil, marine and noise pollution. Penalties have been prescribed for those contravening the provisions of the Act.

The two primary deliberations of the Act are the conduct of projects only after approval of environmental assessments from the SEPA and adherence with (SEQS).

Approval from Sindh Environment Protection Agency

As per the 2014 Regulations, Proponent will submit an EIA report for their project activities to SEPA and seek approval on the same from the agency. Ten hard copies and 2 soft copies of the EIA report will be submitted to SEPA. It will then grant its decision on the EIA as per the rules and procedures set out in the 2014 Regulations. The following rules will apply:

- The EIA/ IEE submission is to be accompanied by an application in the format
- The EIA/ IEE submission is to be accompanied by an application in the format prescribed in Schedule V of the 2014 Regulations;;
- SEPA is bound to conduct a preliminary scrutiny and reply within four weeks of the submission of the report
  a) Confirming completeness, or
  b) Asking for additional information, if needed;

- The proponent will publish a public notice in any English or Urdu national newspaper and in a local newspaper of general circulation in the area affected by the project. The public notice will mention the following:
  - The type of project;
  - The location of the project;
  - The name and address of the proponent;

- The places at which the EIA/ IEE can be accessed;
- The date, time and place for public hearing of any comments on the project or its EIA/ IEE;

- The date set for public hearing will not be earlier than fifteen (15) days from the date of publication of the public notice
- In the review process SEPA may consult a Committee of Experts, which maybe constituted on the request of the DG SEPA;
- On completion of the review process, the decision of SEPA will be communicated to the proponent in the form prescribed in Schedule V;
- Where an EIA/IEE is approved, SEPA can impose additional controls as part of the conditions of approval;
- SEPA is required to make every effort to complete the EIA review process within four months;
- The approval will remain valid for the project duration mentioned in the EIA but on the condition that the project commences within a period of three years from the date of approval. If the project is initiated after three years from approval date, the proponent will have to apply for an extension in the validity period. The SEPA on receiving such request grant extension (not exceeding 3 years at a time) or require the proponent to submit a fresh EIA if in the opinion of SEPA changes in baseline conditions or the project so warrant;
- After receiving approval from SEPA the proponent will acknowledge acceptance of the conditions of approval by executing an undertaking in the form prescribed in Schedule VI of the 2014 Regulations;
- The 2014 Regulations also require proponents to obtain from SEPA, after completion of the project, a confirmation that the requirements of the EIA and the conditions of approval have been duly complied with;
- The SEPA in granting the confirmation of compliance may impose any additional control regarding the environmental management of the project or the operation, as it deems necessary.

2.4 SINDH ENVIRONMENTAL PROTECTION AGENCY REVIEW OF IEE AND EIA REGULATIONS, 2014

The SEPA of IEE and EIA Regulations, 2014 (The 2014 Regulations) promulgated under SEPA 2014 were enforced on December 2014. The 2014 Regulations define the applicability and procedures for preparation, submission and review of IEEs and EIAs. These Regulations also give legal status to the Pakistan Environmental Assessment Procedures prepared by the SEPA in 2014.

The Regulation classifies projects based on expected degree of adverse environmental impacts and lists them in three separate schedules. Schedule I lists projects that may not have significant environmental impacts and therefore require an IEE. Schedule II lists projects of potentially significant environmental impacts requiring preparation of an EIA. The Regulations also require that all projects located in environmentally sensitive areas require preparation of an EIA

As per Sindh Environmental Protection Agency, Government of Sindh notificationNO.EPA/TECH/739/2014, a project falling in any category listed in Schedule-I shall file an IEE with the Agency, and the provisions of section 17 shall apply to such projects.

- Schedule I (IEE)
- Category B,Waste-to-energy generation

The Sindh Environmental Quality Standards

During the construction and post development phase of the project SEQS will be applied to all effluents, gaseous emissions and Noise generation. SEQS for municipal and industrial effluents, selected gaseous pollutants from industrial sources and motor vehicle exhaust and noise have been annexed as Annexure I of this report.

Land Acquisition Act, 1894

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

Pakistan Penal Code (1860)

The Pakistan Penal Code (1860) authorizes fines, imprisonment or both for voluntary corruption or fouling of public springs or reservoirs so as to make them less fit for ordinary use

The Antiquities Act, 1975

The Antiquities Act of 1975 ensures the protection of cultural resources of Pakistan. The Act is designed to protect 'antiquities' from destruction, theft, negligence, unlawful excavation, trade, and export. Antiquities have been defined in the Act as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, national monuments, etc. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area that may contain articles of archaeological significance.

Under the Act, the project proponents are obligated to:

- Ensure that no activity is undertaken in the proximity of a protected antiquity;
- Report to the Department of Archeology, Government of Pakistan, any archeological discovery made during the course of a project

The Factories Act, 1934

The clauses relevant to the project are those that concern to health, safety and welfare of workers, disposal of solid waste and effluent and damage to private and public property. The Factories Act also provides regulation for handling and disposal of toxic and hazardous materials

Hazardous Substance Rules, 2014

The Sindh Hazardous Substances Rules, 2014 are a set of rules derived from the Sindh Environmental Act, 2014 and are first of the very specific hazardous substances regulations brought into force in 2014 after the initial draft set of rules devised in 2003. They represent specific regulations with aspect of handling, storage and disposal of hazardous substances and issuing an approving license to the user or facility. The Schedule-I of the Rules enlists the hazardous substances that are under the scrutiny of the SEPA

Under its licensing terms, the Rules highlight particular components as follows:

- Employment of Qualified technical personnel;
- Packing and labelling;
- Conditions of Premises;
- Safety precautions;
- Trainings;
- A comprehensive safety plan;
- Waste management Plan and
- Transporting of hazardous substances

Sindh Wildlife Protection (Amendment) Act 2008

The Sindh Wildlife Ordinance 1972 empowers the government to declare certain areas reserved for the protection of wildlife and to control activities within these areas. It also provides protection to endangered species of wildlife

Sindh Forest Act (2012)

The act empowers the provincial forest departments to declare any forest area as reserved or protected. The Act also empowers the provincial forest departments to prohibit the clearing of forest

for cultivation, grazing, hunting, removing forest produce; quarrying and felling, lopping and topping of trees, branches in reserved and protected forests

Sindh Fisheries Ordinance (1980)

The sindh Fisheries Ordinance, 1980 regulates fishing in the public waters, including the coastal areas, of Sindh. It empowers the government of Sindh to issue licenses for fishing in pubic waters, put restriction on the type of equipment that can be used for fishing, restrict fishing in certain areas or of certain species of fish, regulate the onshore trade of fish catch, and regulate the fish processing industry. Article 8 of the Ordinance prohibits the discharge of wastewater to public waters without the consent of the Director Fisheries

Highways Safety Ordinance, 2000

This ordinance includes provisions for the licensing and registration of vehicles and construction equipment; maintenance of road vehicles; traffic control, offences, penalties and procedures; and the establishment of a police force for motorways and national highways charged with regulating and controlling traffic on the national highways, and keeping the highways clear of encroachments

2.5 NATIONAL AND INTERNATIONAL GUIDELINES OR STANDARDS

The Pakistan Environmental Assessment Procedures, 1997

The Pakistan Environmental Protection Agency prepared the Pakistan Environmental Assessment Procedures in 1997. They are based on much of the existing work done by international donor agencies and Non-Governmental Organizations (NGOs. The package of regulations prepared by PEPA includes:

- Policy and Procedures for Filing, Review and Approval of Environmental Assessments;
- Guidelines for the Preparation and Review of Environmental Reports;
- Guidelines for Public Consultation;
- Guidelines for Sensitive and Critical Areas; and
- Sectoral Guidelines for various types of projects

World Bank Guidelines on Environment

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

- Environmental Assessment-Operational Policy 4.01. Washington, DC, USA. World Bank 1999.

- Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross-Sectoral Issues. World Bank Technical Paper Number 139, Environment Department, the World Bank, 1991

The above two publications provide general guidelines to conduct the EIA's, and address the EIA practitioners themselves as well as project designers. While the Sourcebook in particular has been designed with Bank projects in mind, and is especially relevant for the impact assessment of large-scale infrastructure projects, it contains a wealth of useful information, for environmentalists and project proponents

The Sourcebook identifies a number of areas of concern, which should be addressed during impact assessment. It sets out guidelines for the determination of impacts, provides a checklist of tools to identify possible biodiversity issues and suggests possible mitigation measures. Possible development project impacts on wild lands, wetlands, forests etc. are also identified and mitigation measures suggested.

OSHA Standards Health Safety

The Occupational Safety and Health Administration (OSHA) are issuing safety and health program management guidelines for use by employers to prevent occupational injuries and illnesses. The Occupational Safety and Health Act of 1970 (OSHA) representatives have noted a strong correlation between the application of sound management practices in the operation of safety and health programs and a low incidence of occupational injuries and illnesses. Where effective safety and health management is practiced, injury and illness rates are significantly less than rates at comparable worksites where safety and health management is weak or non-existent

The Occupational Safety and Health Administration (OSHA) have concluded that effective management of worker safety and health protection is a decisive factor in reducing the extent and the severity of work-related injuries and illnesses. Effective management addresses all work-related hazards, including those potential hazards which could result from a change in worksite conditions or practices. It addresses hazards whether or not they are regulated by government standards

2.6 OBLIGATION UNDER INTERNATIONAL TREATIES

Pakistan is a signatory to various international treaties and conventions on the conservation of the environment and wildlife protection. The country is obliged to adhere to the commitments specified in these treaties list of applicable set of treaties and conventions are presented below:

London Dumping Convention 1972

The London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter was agreed in 1972. The London Convention defines a Black List of toxic substances, the disposal of which, by dumping into the sea, is prohibited, and a Grey List of less hazardous substances that may only be dumped under a prior special permit; the dumping of any other wastes not specified in these lists requires a prior general permit. In 1990, the London Convention was amended to require signatory countries to consider whether an adequate scientific basis exists for assessing the environmental impact of a substance (i.e. dredged material) before issuing a permit for dumping.

United Nation Convention on Law of the Sea (UNCLOS-82)

The UN Convention on the Law of the Sea was adopted and opened for signature in 1982. On November 16, 1994, it entered into force for 68 countries. Pakistan is a signatory to the Convention. The Convention establishes a comprehensive framework for use of the ocean and its resources. Its 320 articles, supplemented by nine detailed annexes, specify the rights all nations may exercise in the world oceans and their responsibility to do so with due regards for the rights and interests of other nations. The preservation and protection of the marine Environment and the conservation of marine living resources are fundamental obligations. The Law of the Sea Convention represents the first comprehensive statement of international law on protection and preservation of the marine environment and provides a legal and institutional framework for marine environmental protection and related dispute settlement. It establishes a basic structure of obligations, objectives and principles covering all sources of marine pollution that include Pollution by vessels (operational and accidental discharges from ships); dumping (the deliberate disposal of wastes at sea by ships, aircrafts, platforms, or other manmade structures).The Convention establishes the General Principles for the preservation and protection of the marine environment and identifies the source categories for the prevention, reduction and control of marine pollution. It discusses in detail issues such as response to marine pollution emergencies.

Chapter 3

DESCRIPTION OF THE ENVIRONMENT

3.1 GENERAL

This Chapter describes the detailed description about the physical environmental condition. The data collected includes the information relating to topography and land use, geology, climate, air and water resources. The information and data presented in this part of the report is based on the surveys conducted by the team of experts and supplemented with the secondary data from published literature and previously conducted studies within the proposed project area. The base line data defines the present physical environmental quality of the proposed project site and adjoining areas.

3.2 PHYSICAL ENVIRONMENT

Physiography

On the basis of the physical environment and geology, the project area falls in the Indus Basin, which is briefly described below.

The Indus Basin essentially forms the western extension of Indo-Gangetic Plain, and has been made up of the silt brought by the Indus and its numerous tributaries, such as Jhelum, Chenab, Ravi and Sutlej on the east bank, and Kabul, Kurram, Tochi, and others on the west bank. The Indus Plain is known for its agricultural fertility and cultural development throughout history.

The left bank tributaries of the Indus River all meet at Panjnad and flow as one large stream for about 75 km before joining the Indus at Mithankot, and south of it, the Indus flows almost alone up to the Arabian Sea without receiving any noticeable tributary.

The average annual discharge of the Indus – 92 million acre feet (MAF) at Attock Khurd –is much higher than the combined discharge of its tributaries. There is a great fluctuation in their seasonal discharge, especially in the hot summer and rainy season. Almost all of its tributaries and the Indus itself have their sources in snow and glaciated areas of Himalayan, Karakoram and Hindukush mountain systems.

On the basis of hydrology and land form, the Indus Plain can be divided into the Upper and Lower Indus Plains. The Upper Indus Plain differs from the Lower Indus Plain (where the project area is located) primarily because of the major tributaries (Jhelum, Chenab, Ravi and Sutlej) divide the land surface into several interfluves or '*doabs*'. The two planes are separated by a narrow corridor near Mithankot where the Sulaiman range approaches the Indus River. The Lower Indus Plain is very flat, generally sloping to the south with an average gradient of 95 mm per km (6 inches per mile). The

Lower Indus Plain can be divided in five distinct micro-relief land forms: active flood plain; meander flood plain; cover flood plain; scalloped interfluves; and the Indus delta. In the northeast, the meander flood plain is more extensive, while in the central and lower Indus Plain, the cover flood plain is more prominent.

3.3 TOPOGRAPHY

Topographically, Sindh can be divided into four distinct parts with the dry and barren Kirthar Range in the west, a central alluvial plain bisected by the Indus River, a desert belt in the east, and the Indus delta in the south. The entire project area is located in the central alluvial plain on either sides of the Indus River.

Geological Setting

The prevailing geologic conditions in the region are the results of extensive inundation, depositions, coastal movements, and erosions over a long period of time in the geological ages. The geology of the region is closely related to the formation process of Himalayan ranges resulting in intense deformation with complex folding, high angle strike-slip faults and crust thickening expressed in a series of thrust faults. The important tectonic changes which have had so much influence in the region are feebly visible particularly in the Indus Plain, and it is only by considering the geology on a broader regional scale, as well as in site specific detail, that the effects can be appreciated.

Most parts of Sindh are covered either by recent alluvium or wind-borne sand. The principal features of geological significance are to be found in the hilly portions of the province, towards the west of the Indus. Outlying extensions of this hilly tract occur east of the Indus as well, near Sukkur, Hyderabad and Jerruck. The isolated hills of Nagarparkar on the northern border of the Rann of Kutch belong to quite a different system both geographically and geologically.

The hilly region of western Sindh consists almost entirely of rocks belonging to the tertiary system of geological nomenclature. It is only along the Laki Range and in its neighborhood that there are some exposures of rocks belonging to the next older system, the Cretaceous. With the exception of some volcanic beds associated with these Cretaceous strata, all the rock formations of western Sindh are of sedimentary origin. All of the more important hill masses consist of limestone. A great majority of these limestone deposits belong to the Nummultic period and are largely built up of the accumulated shells of foraminifera, principally those belonging to the genus Nummulites.

Soils

The soil in the plains of Sindh is plastic clay that has been deposited by the Indus. Combined with water it develops into a rich mould and without water it degenerates into a desert. Nearly the entire Indus valley has soil which is extremely friable and easily disintegrated by the flow of water. Resultantly, the water always contains a large amount of suspended silt.

Land Use

Agriculture, followed by forestry, is the main land use in the central alluvial plain. Although more than 50 percent of the total geographical area is cultivable, only 26percent of it is actually located in the central plain. The land inside the Indus embankments is almost equally employed by agriculture and forestry, while that outside the embankments is more extensively utilized for agriculture in the form of sparsely distributed irrigated plantations. The land use in Sindh is given in **Exhibit 4.1**.

3.4 METEOROLOGY AND CLIMATE

Meteorology

The climate of most parts of the Project Area is arid characterized by four district seasons in a year, that is, winter from Mid-November to February, spring during March and April summer from May to Mid-September and autumn from Mid-September to Mid-November. There exist several meteorological stations in the project area; data recorded at Hyderabad stations is provided in the following sections.

Temperatures

June is the hottest month in most parts of the project area, with mean daily maximum temperature recorded as 44.33 °C.4 January is the coldest month in the area, with the mean daily minimum temperature recorded as 5.42 °C.5 Mean daily maximum and mean daily minimum temperatures of various districts in the project area are presented in **Exhibits 4.2** and **4.3**, respectively.6 In view of the very small differences among these temperatures, this data can be taken as representative for the entire project area.

Rainfall

Average annual rainfall in the project area ranges between 1.17 mm (Jacobabad) and 60.75 mm. Maximum rainfall (about 60% of the total annual) occurs during the Monsoon season (July, August and September), while the period of minimum rainfall or drier period is October and November. Mean monthly rainfall data of various locations within the project area is provided in **Exhibit 4.4**.7

Humidity

July, August and September are the most humid months in the area, whereas May and June are the least humid months. Average monthly relative humidity recorded in the project area is provided in **Exhibit 4.5**.8

Month	Maximum	Minimum	Precipitation	Humidity
January	25.04	11.08	1.17	47.90
February	28.15	13.62	3.87	45.38
March	33.38	18.50	5.05	42.40
April	38.87	22.98	5.74	41.88

May	41.62	26.16	3.47	46.96
June	40.15	28.07	13.84	56.35
July	37.40	27.81	56.66	63.42
August	36.30	26.71	60.75	65.26
September	36.84	25.34	21.14	61.37
October	37.19	22.27	1.50	47.65
November	31.95	17.29	2.10	46.40
December	26.27	12.50	1.99	49.26
Annual	34.47	21.03	177.55	51.19

Source: Data Processing Centre, Pakistan Meteorological Department, Karachi
a Measured at Hyderabad Air Port. b Measured at Chor. C Measured at Nawabshah.

The study area falls in Tropical Semi-arid Dry Winter

Ambient Air Quality

The project site is located close to the roads experiencing vehicular traffic, which causes air pollution. At project site the ambient air quality is expected to exceed the acceptable limits defined by the national and international standards (given in **Exhibit 2.4**), in view of the heavy vehicular traffic at these places. Since the primary source of air pollution at the above sites is the vehicular emissions, the key pollutants likely to be found at these locations include carbon monoxide (CO), oxides of nitrogen (NO_X), sulfur dioxide (SO_2), and particulate matter (PM).

The agricultural activities do cause some environmental degradation associated with the use of agro chemicals and operation of agricultural machinery. However, this degradation is of low level since the project area is not known for heavy use of agrochemicals such as pesticides, or agricultural machinery. As a result, the ambient air quality of these sites is expected to be well within the acceptable limits, and no major criteria pollutants are likely to be found in excess of the limits prescribed by national and international standards (see **Section 2.2.3** for the ambient air quality and emission standards).

3.5 SURFACE WATER RESOURCES

The River Indus is the prime surface water resource of Sindh. The Indus River exhibits great seasonal variations, with more than 80% of the total annual flow occurring during the summer months, peaking in June, July and August. **Exhibit 4.9** presents flow data of the Indus.

The Indus River and its tributaries on an average bring about 154 MAF of water annually. This includes 144.9 MAF from the three western rivers and 9.14 MAF from the eastern rivers. Most of this, about 104.7 MAF is diverted for irrigation, 39.4 MAF flows to the sea and about 9.9 MAF is consumed by the system losses which include evaporation, seepage and spills during floods. The

flows of the Indus and its tributaries vary widely from year to year and within the year. As is the case with the water availability there is significant variation in annual flows into sea.

Lakes: There exist several fresh water and brackish lakes in the Sindh province. The salient among these include Manchar, Keenjhar and Haleji lakes (further discussed in **Section 4.2**). In addition there exist a large number of small lakes and ponds in the irrigated areas of Sindh, most of which have been created as a result of extensive irrigation and very shallow groundwater.

Groundwater Resources

The Indus Basin was formed by alluvial deposits carried by the Indus and its tributaries. It is underlain by an unconfined aquifer covering about 15 million acres (60,700 km2) in surface area. In Sindh, about 28% of the area is underlain by fresh groundwater. This is mostly used as supplemental irrigation water and pumped through tube-wells. Some groundwater is saline. Water from the saline tube-wells is generally put into drains and, where this is not possible, it is discharged into large canals for use in irrigation, after diluting with the fresh canal water.

The quality of groundwater ranges from fresh (salinity less than 1,000 mg/l TDS) near the major rivers to highly saline farther away, with salinity more than 3,000 mg/l TDS. Generally, the quality and quantity of groundwater in the Indus Basin deteriorate from north to south, and from east to west.

Biological Resources

This section provides an overview of the ecozones, wild flora and fauna, and the habitat conditions prevailing in the project area. The description in this section has been prepared on the basis of secondary literature review, and field visits.

3.6 ORIGINAL ECOZONES OF PROJECT AREA

Tropical Thorn Forest Ecozone

This habitat was the most extensive ecozone of the Indus plain, and currently exists only in places where the land has not been converted for habitation or cultivation. This habitat comprises low forests of thorny and hard-wooded tree species, dominated by *Acacia* spp. The trees of such forests have short boles and low branching crowns. These are usually not close-growth trees hence their canopies touch each other in exceptionally favorable spots. The usual height of the trees is 20-30 feet (6-9 m).

Other plants that grow mixed with *Acacia* include *Salvadora, Prosopis, Capparis,* and *Tamarix.* The shrubs of theecozone included *Calotropis, Zizyphus, Suaed,* while herbs of the area included *Chenopodium, Calligonum, Haloxylon* and various species of grasses.

The major wildlife mammal species of this eco zone was Long-eared Hedgehog, Desert Hare, Porcupine, Desert Wolf, Jackal, Bengal Fox, Desert Fox, Honey Badger, Small Indian Civet, Grey Mongoose, Small Indian Mongoose, Striped Hyena, Indian Desert Cat, Caracal, Jungle Cat, Wild

Boar, Nilgai, Blackbuck and Chinkara Gazelle. **Appendix D** provides a list of the key mammalian species of the area.

Birds of the eco zone included Grey Partridge, Peafowl, Common Quail, Ring Dove, Red Turtle Dove, Little Brown Dove, Green Pigeon, Hoopoe, Spotted Owlet, Barn Owl, Dusky Horned Owl, Indian Nightjar, Wryneck, Golden-backed woodpecker, Pied Wood pecker, Wood Shrike, Great Grey Shrike, Rufous-backed shrike, Fantail Flycatcher, Common babbler, Jungle babbler, Houbara Bustard, Great Indian Bustard and many other species of passerine birds. **Appendix D** provides a list of the key bird species of the area.

Reptiles of the area included Bengal Monitor Lizard, Garden Lizard, Spiny-tailed Lizard, Cobra, Krait, Vipers and Rat Snake. **Appendix D** provides a list of the key reptilian species of the area.

Riverine Tract Habitats

Originally the riverine habitats used to have heavy, seasonal floods. Since forecasting and prior warning were not available to the rural people, these habitats were not occupied for agriculture and habitation. Natural resource exploitation was also not extensive. As a result, this natural flora along the rivers flourished. These included: *Tamarix, Saccharum, populus* and *Acacia. Typha* growth was common wherever the water was stagnant or slow moving.

The mammals of such habitat included Hog Deer, Wild Boar, Fishing Cat, Jungle Cat, Small Indian Civet, Smooth-coated Otter and Indus Blind Dolphin. The wild avifauna of the area included around forty species of Ducks and Geese, Black Partridge, Countless number and species of waders, Purple Moorhen, Common and White-breasted Moorhen, Yellow-eyed Babbler, and several Passerine species. The key reptiles of the area included Monitor Lizard and several species of Turtles.

Modified Nature of Habitat

Major parts of the original habitats described in **Section 4.2.1** above have been modified into new habitats, primarily as a result of extensive cultivation and expanding urban centers as well as rural settlements. These new habitat types are briefly discussed below.

Agricultural Habitats

Most parts of Sindh are under very intensive irrigated cultivation. In addition, livestock rearing is also practiced extensively, and milk animals are common. The use of the chemical fertilizers and pesticides is very common. Several species of wildlife have adapted to the changed habitat. These include: Jackal; Jungle Cat, Bengal Fox, Small Indian Mongoose, Shrew, Rodent pests including Porcupine, Fruit Bats and Wild Boar.

The avifauna which survived the modified habitat include Doves, Black Partridge, Cuckoos, Koel, Woodpeckers, Parakeets, Bulbuls, Babblers, Black Drongo, Bee-eaters, Finches and House Sparrow.

The reptilian species of this modified habitat include Krait, Cobra, Saw-scaled Viper, Rat Snake and Monitor Lizard.

In these modified habitats, the winter bird species from Himalayas have reduced due to the extensive use of pesticides in these areas, since these species feed on the insects. These birds play an important role in controlling insects particularly in the forests. Almost all of the project components are located in this type of habitat.

Rural and Urban Habitats

These include human habitations within agriculture areas, as well as the urban centers. Scavengers like Jackals are attracted to the garbage dumps and human feces for food. House Sparrows breed in the houses. Bank Mynas and Cattle Egrets feed on grasshoppers in the rangelands with cattle and buffalos. Banyan and Peepal trees still grow in villages. Green Pigeons and barbets feed in these trees. Some of the oldest trees still stand in the old British era colonies. Some rare species of birds such as hornbills, Green Pigeon and Barbets still live on them. Large populations of Pigeons breed in urban houses. Kites, Crows, Mynas, House Sparrows, and Alexandrine Parakeets breed in the urban areas. Usually Shisham and Acacia trees are planted alongside the roads and canals. Mostly Doves breed on such trees.

Migratory Birds

There are many migratory bird species, which still visit or pass through the modified eco zones. These include geese and ducks, cranes, many waders, raptors and large variety of passerine birds such as larks, cuckoos, rooks, ravens, starlings, tits, warblers and finches. Some of these birds fly in to stay for the winter, while the rest fly through. For many species the province serves as a breeding ground while others procreate in other areas but have been spotted in this region. **Appendix D** presents a list of the important bid species of Sindh.

Wetlands

Wetlands are among the most productive ecosystems in the world. Since Pakistan is situated on the flyway to Central Asia and South Asia, the birds breeding in Central and Northern Asia, migrate through Afghanistan to the Indus Valley, particularly to the wetlands across Sindh which are major wintering grounds of migratory water birds.

Protected Areas

There exists neither national park nor wildlife sanctuaries. or game reserves in the project area.

Environmental Hotspots

In view of the greatly modified nature of the habitats, there do not exist any environmental hotspots at or around any of the proposed project area..

Culture and Customs

Sindh province has rich culture, customs and traditions. Various parts of the project area have almost similar culture and customs with slight differences on the basis of ethnic and religious groups. Being traditional Muslims there is a greater influence of the Arabian culture, however, the traces of Hindu, Buddhism and other religious thoughts are also present in the cultural attitudes and approaches of the local communities. The *Pirs* and *Murshids* (religious leaders, saints) are held in high esteem and confidence amongst the Muslims particularly in the uneducated and poor class of the rural areas. Annual festivals at the shrines of saints are regularly held in which people very enthusiastically take part. Similarly, the Hindus also hold great confidence and reverence in Thakurs and Brahmans (the higher castes). The Brahmans usually perform spiritual rites of Hindus on special occasions. Sindhi is the common language in the project area whereas Siraiki, Balochi, Brohi and Urdu are also spoken in various parts of the province.

Ethnicity and Castes

Majority of the population in the project area is Muslim and Sindhis. The population of the is a mixture of various heterogeneous groups and cultures. The main races are Talpurs, Syeds, Balochs, Soomra, Mirza, Sheikhs, Memon, Khatris, Qureshis and Abbasis. Besides the main religious groups in the district are Muslims and Hindus. The main castes among Muslims include Syed, Talpur, Memon, Bhurgri, Lashari, Laghari,Ranghar, Panwhar, Halepota, Marri, Banglani, Gorchani, Khosa, Sameja, Gurgaj,Bhambhro, Jat, Arain, Qureshi and Sheikh. Amongst the Hindus most prominent are Brahman, Malhi, Lohana, Kirars, Soothar and Maheshwaveri. A reasonable number of Urdu-speaking migrants from India, some Pashtuns (pathans) and Punjab are also living in the area.

Main Occupations

Cultivation and the related businesses are the main occupations in the project area. The other key economic activities include livestock rearing, and government as well as private sector jobs. The farmers in this district traditionally keep a few heads of livestock, ranging from bullocks for draught to cows and buffalos for milk, and poultry for eggs and meat. There have been many traditional communities in the area exclusively dependent on livestock for their livelihood, however, the importance of livestock as a source of income has declined over the years. Good breeds of buffalos and cows are found in these districts.

Gender Perspectives

There are slight differences in the gender perceptions, attitudes, roles and responsibilities central Sindh. The tribal clans in the central Sindh are more conservative with regard to women and their status, roles and responsibilities.

The women particularly in the rural areas have fewer rights in all the aspects of their lives. The literacy data clearly corroborates this, and indicates that compared to men, the women are far behind in education, which is a key development indicator. Furthermore, this disparity is more generally

prominent in the rural communities. The male and female literacy in urban areas of Sindh is 69.75 and 56.66 percent, respectively (1998 census data). Whereas in the rural areas, the female literacy is only 12.23 percent compared to the male literacy, which is 37.89 percent. The rural female literacy is quite low in the project area.

Women in most rural communities in the project area equally participate in livelihood activities along family lines. However, there exists a difference in mobility between Muslim and Non-Muslim women. Women from non-Muslim community work in the field right from the weeding to the harvesting. These women also receive money from farmers at the harvest; as such they are equal work sharers with men.

While the Muslim women only work in the field at the harvest time. They do not frequency visit fields for work at any other time during the year.

Almost in all of the project area, women role in decision-making is also negligible. They mostly remain subordinate to men throughout their lives regarding important decisions concerning them and the family. Unmarried girls are preferred to stay at home or work infields. Usually they are married at an early age. Exchange marriages are a common feature in the rural communities.

Women's household role is taken for granted. Since their work inside the house and in the fields goes largely unpaid, they cannot assert economic independence and this affects their status to a large extent. Agriculture economy in the villages and cultural values discouraging women mixing with men hamper women's access to the markets. Therefore, men get control on all capital, monetary and productive resources.

Education and Health

The overall literacy of Sindh is 45.29 percent (1998 census data). The urban literacy is 63.72 percent which is substantially higher than the rural literacy which is 25.75 percent. The overall educational enrolment in the entire Sindh province is also quite dismal.

A large number of educational institutions exist in the project area. These include primary, secondary and higher secondary schools, as well as colleges A considerable number of health care facilities exist in the project area. These include a civil hospital (District Headquarter Hospital) in every district, Taluka Hospitals, Basic Health Units (BHUs), Rural Health Centers (RHCs), maternity homes, and dispensaries. However, their numbers compared to the population in the area are not sufficient to provide adequate coverage. Moreover, in the existing facilities, lack of trained staff, and shortage of medicines as well as medical instruments are some of the key problems – rendering most of these facilities particularly in the rural areas less effective if not outright dysfunctional. A particular problem in access to health services is the scattered nature of the population in the rural areas. As a

result, many rural communities do not have any medical facilities and the people from such areas usually face considerable hardships in going to the urban centers for the treatment of serious diseases.

This situation is even more dismal for the women, particularly in the rural communities. The women-exclusive health facilities, such as maternity homes, are very few and there is severe shortage of female health staff, either medical or paramedical staff.

Agriculture

The project area falls which is characterized by extensive cultivation, high summer temperatures and low rainfall?

Agriculture is the key source of livelihood in Sindh since the majority of population is associated with this sector. About 80% of the agriculture land of the province is cultivated through controlled irrigation system.

The major crops of Sindh include rice, wheat, cotton, sugarcane and oilseeds. Sindh is also known for its orchards; mango, banana, guava and dates being some of the key fruits. Wheat and rice are the key crops in the project area, whereas sugarcane and cotton are also some of the important crops of the area.

Irrigation System

The project area falls in the Indus Basin Irrigation System (IBIS), which comprises of three major reservoirs, 16 barrages, 2 head-works, 2 siphons across major rivers, 12 inter river link canals, 44 canal systems (of which 14 lie in Sindh) and more than 107,000 water courses.

Groundwater Irrigation

An estimated 41.6 MAF of groundwater is pumped annually in Pakistan. According to a study, more than 90% of the extracted groundwater is used for irrigation purposes. Groundwater reservoirs are recharged from the rivers as well as the seepage losses from the canals, watercourses, farm channels and the fields.

3.7 FAULTS, EARTHQUAKES AND SEISMIC HAZARD

Being located close to the collision boundary of the Indian and Eurasian plates, Pakistan lies in a seismically active zone. Pakistan is located in the Indus-Tsangpo Suture Zone, which is roughly 200 km north of the Himalaya Front and is defined by an exposed ophiolite chain along its southern margin. This region has the highest rates of seismicity and largest earthquakes in the Himalaya region, caused mainly by movement on thrust faults. Seismic zone mapping of Pakistan has divided the country into four seismic zones ranging in term of major, moderate, minor and negligible zones with respect to ground acceleration values. Under this zoning district Tando Allahyar identified in a zone which has minor to moderate damaging affect.

Chapter 4

REVIEW OF ALTERNATIVES

4.1 ALTERNATIVES

It is the requirement of the Asian Development Bank as well as best practice that the EIA should consider project alternatives and their relative potential impact on the environment. Alternatives must, however, be both practical and reasonable, within the overall constraints of the proposed project development.

4.2 NO ACTION (ZERO OPTION)

This option requires the EIA to consider the potential positive and negative impacts that may arise if the project did not go ahead.

The project will be using available quantity of bagasse (renewable energy source) for additional generation of 13.8MW electricity during 120 days of cane crushing season and for around 60 days of off-season at 23.8 MW to supply much needed power to national grid. Displacement of fossil fuel energy production during bagasse use period will also result in a net reduction in CO_2 emissions so contributing to the control of climate change.

The project would also provide additional revenue to the sugar industry which will help to secure its future and so offset some of the current and increasing pressures on the financial viability of the sugar sector.

The zero option would, however, remove the potentially negative impacts of the proposed development, primarily associated with the clearing of existing ecological habitats during the construction of the transmission line to Grid Station near Tando Allahyar. However there is already a grid in the close proximity to the proposed power plant.

4.3 PROPOSED POWER PLANT SITE

When the need for additional power generation capacity was confirmed, MEL had reviewed a number of siting options prior to the selection of the final proposed location.

- Selection of site for installation of a cogeneration power plant is based on following criteria: Availability of land;
- Availability of fuel
- Availability of water for cooling and process;
- Access to electric grid station and transmission system;

- Availability of infrastructure;
- Availability of managerial and skilled personnel.

The cogeneration power plant, under reference of this EIA is intrinsically linked with the sugar factory as discussed within the project description. This linkage is twofold, firstly the supply of bagasse from the factory to the cogeneration power plant and secondly the provision of steam to the factory from the cogeneration plant with the return of good quality condensate. Due to the physical restrictions within the MSML factory site and the requirements for the two plants to be in close proximity, no practical alternative site locations exist, except the site that has been proposed

Major relocation of the plant, away from the MSML sugar factory, would add significant additional capital and operational costs (steam/condensate pipe work and bagasse transport) and was not therefore considered a practical or reasonable option. The base case site is also the least environmentally sensitive of any alternative location that may exist around the site

The proposed site; adjacent to the MSML; has the entire infrastructure available. Water will be available from tube-wells (ground water) and an alternative surface water source of nearby canal; NTDC / HESCO proposed grid station is located at about 2 kilometers distance; adequate workshop and maintenance facilities, along with trained, experienced and skilled workshop technicians are available who are already running the workshop available at MSML. Similarly, experienced and skilled managerial manpower is also available in the area.

4.4 COGENERATION OPTION

Cogeneration has been adopted as standard means of energy generation since long by the sugar industry. With the use of efficient processing and energy management systems, energy from bagasse, over and above the sugar factory needs, is available and can be exported conveniently in the form of electric power. Application of sugar cogeneration will replace a part of fossil-based electricity generation leading to a more sustainable mix in power generation.

Cogeneration with power export will assist in reducing greenhouse gases (GHGs) emissions. In order to continue reliable, efficient and safe operation, the existing steam and power generation system will be closed down and replaced with the more efficient system in proposed power plant. Presently, sugar industry world-wide except for Pakistan uses high-pressure boilers by burning bagasse and the high pressure steam for power generation and the low pressure steam for process heat. Introduction of high-pressure technology in Pakistan will result in more power production to supply to the national grid and less emission of GHG.

Options for Boilers

The only option to use the bagasse effectively is the combustion route, where the bagasse is combusted in a boiler to generate steam. However, because of the nature of and characteristics of

bagasse, both atmospheric & circulating fluidized bed technologies (AFBC and CFBC) and the pulverized fuel (PF) combustion technologies are not suitable for the stand-alone combustion of bagasse.

Many options are available for selection of boiler pressures and temperature. Table - 4.1, below, presents the production of steam and expected power generation at various pressure/temperature levels.

Table 4.1: Production of Steam and Power Generation

Steam Cycle (Bar/o C)	Steam Production (tonnes)	Power Generation (kW)
21/340	2,50	227.3
32/380	2.43	286.0
42/400	2.40	313.0
45/440	2.33	328.0
67/480	2.27	378.0
87/510	2.24	401.0
110/535	2.21	437.0

Using bagasse as fuel and travelling grate furnace, the optimum option is selection of boiler pressure at or close to 110/535 (pressure/temperature). At higher pressures the steam turbine efficiency also increases. A change in pressure cycle from 21/340 to 110/535 increases the power generation by 88%. Under the circumstance the selected boilers with high pressure is the best alternative. MEL is considering with a 67/580 or 110/535 boiler.

Fuel Options

Fossil energy resources consist primarily of natural gas and furnace oil. Domestic oil supply is considered negligible and natural gas resources are becoming scarce in Pakistan. However, substantial coal deposits are available in the country, but mining of all of them is quite expensive. Moreover, domestic coal is very high in sulphur and ash content, which will lead to severe environmental hazards. Since the proposed power plant is situated in a rich cane area that offers to be the ideal fuel source.

4.5 RENEWABLE ENERGY ALTERNATIVES

Renewable resources such as wind power, micro hydro, and solar photovoltaic are not feasible options at the current time, but are subject to future consideration, particularly with respect to the price of fuel. With availability of bagasse for approximately 180 days the option of using other renewable energy sources will be highly cost ineffective.

Chapter 5

ANALYSIS OF ENVIRONMENTAL IMPACTS

5.1 METHODOLOGY FOR ANTICIPATING ENVIRONMENTAL IMPACTS

Baseline data and conditions form the basis for evaluation of the environmental impacts of the proposed power project. A tabulated evaluation procedure has been used for the purpose of the presentation. The severity of the impact is presented on point scale. The evaluation scale used for the EIA Study is given below:-

Scale: Extent of Impact

- ▲▲▲ = High
- ▲▲ = Medium
- ▲ = Low
- O = No impact
- ▼▼ = locally favorable
- ▼ = regionally favorable.

For evaluation rating, the Sindh Environmental Quality Standards (SEQS) are used as guidelines. Various parameters of extent of environmental impacts are described below:

Table 5.1 Evaluation of Impacts - Criteria

Extent of Environmental Impact	Description
• High	International and National Standards are exceeded.
• Medium	Between International and National Standards.
• Low	International and National Standards are met

5.2 ENVIRONMENTAL IMPACTS ASSESSMENT DURING CONSTRUCTION PHASE

This section discusses the potential impacts from the installation of the proposed power plant and associated facilities on the natural resources and environment of the site and vicinity.

Land Acquisition

Land requirement for the proposed project will be met from the land (which was under Industrial use) already procured. No resettlement activities and no expropriation measures are required for realization of the proposed project.

The land required for the proposed project does not represent land of specific ecological importance. The area was assessed as being without any features that are out of the ordinary. No specific mitigation or compensation measures are required.

Extent of Impact of land acquisition = ▲ (Low)

Erosion/Sedimentation

The proposed project do not requires land clearing and site preparation for installation of the power block and associated facilities

No wetlands are present within the project boundaries. The proposed construction area is not anticipated to significantly impact the land on site. Some trees removal will be required in any area where construction conflicts exist. Tree removal from the entire property is not proposed, but only where required for the needs of the project.

General site preparation and construction activities associated with the overall development of the Project site include the following:

- Clearing/grubbing of all un-cleared portions of the construction area and lay down area;
- Stabilizing, grading, filling, and contouring the area for power plant facilities;
- Construction of permanent storm water management system;
- Performing groundwork as necessary for construction of facility footings,
- Foundations and underground utilities including electrical, water, wastewater, and other piping systems;
- Power plant facilities construction; and
- Earthmoving, grading, re-contouring and landscaping.

Site preparation will consist of clearing and grubbing, followed by grading and leveling. Vegetative debris from site clearing will be disposed and topsoil that is suitable for reuse will be stockpiled for landscaping and for establishing vegetation after construction has been completed. During early site preparation activities, temporary storm water management structures and soil erosion and sedimentation control devices (e.g., ditches, retention basins, berms, and siltation fencing) will be used to minimize runoff during the construction phase.

Site preparation and construction activities will not require any explosives. The plant site will be cleared of all vegetation and organic matter in conflict with the proposed construction. Rough grading, excavation, and backfill activities will be performed to prepare the site for underground utilities, concrete foundations, and surface drainage.

Structural backfill materials may be imported to the site for constructing concrete foundations and to raise grade site elevation to achieve proper drainage.

After construction of the power plant project is essentially complete, any remaining areas that do not have an impervious surface will be re-vegetated with native plant materials

The plant site will be altered to construct new facilities. Structural and general fill will be added to elevate the site to design elevations. Soils excavated for the major equipment foundations may be used as general fill or structural fill, if appropriate. Fill may be required to raise portions of the site to grade.

Since the site is in a flat area, the fill should not cause adverse impacts to site topographic conditions. Very little, if any, runoff flows onto the proposed site. Therefore, the fill will not impede existing drainage patterns. Added fill, with compaction, will shift areas of percolation within the site. Runoff will be managed with the storm water management system to mimic pre-construction conditions. During construction, erosion at the site will be managed according to an erosion control plan. After construction, pervious areas will be planted predominantly with native vegetation to control erosion.

Extent of Impact on Erosion/Sedimentation = ▲ (Low)

5.3 AIR QUALITY

Major sources of dust emissions during construction include:

- Land clearing
- Excavation
- Earth work
- Ground leveling.
- Vehicles movement
- Emissions from vehicles and machinery

Dust generation from construction activities is an important concern during construction phase. Dust particles generally larger than 10 μm will settle down close to the construction sites, resulting in visible deposition close to the construction activities. Fugitive dust emissions will be greater during land clearing and site preparation phases. Fugitive dust emissions will also be greater during the more active construction periods as a result of increased vehicle traffic on the site.

The dust to be generated during construction activities is mostly inorganic and of a nontoxic nature. Quantum dust generation will depend on weather conditions, wind velocity, precipitation rate, and type of construction activities.

Dust and grit are expected to be present during the construction phase in dry months. This will end when the major civil works finish. Some dampening of the exposed areas, by employing dust control methods, may therefore be necessary during periods of dry weather in order to reduce the risk of dust entrainment in the ambient air. Peak dust generation, if construction activities coincide, will be during

the drier months and this dust will tend to become dispersed within the ambient air as a result of vehicle movements. It will therefore be necessary to ensure that loads are covered to prevent fine dust blowing from open-top trucks. In dry periods, it may also be necessary employ dust control measures. There will be an overall increase in traffic and heavy machinery movement during peak construction phase for limited period leading to a rise in emission level. These emissions together with exhaust emissions from equipment/machinery deployed during the construction phase might result in marginal increases in the levels of sulfur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), and un-burnt hydrocarbons. However, due to limited duration of the construction period and the use of the equipment at different intervals, the impact on air quality can be considered as low.

Potential minor sources of volatile organic compounds include evaporative losses from onsite painting, refueling of construction equipment and the application of adhesives and waterproofing chemicals

The background levels of these pollutants are considered to be virtually low based upon the low frequency of traffic use proximal to the site. However, even with the predicted increase in construction related traffic and associated site activities, any increase in these pollutants is considered to be almost insignificant.

Fugitive dust emissions from the construction site will be minimized using appropriate dust suppression control methods. These standard control methods will include paving or placement of gravel on roads, applying dust suppressing chemicals or water to roads and other exposed surfaces, or other methods, as needed. The existing public and internal roads on exiting site is already paved.

Spilled and tracked dirt (or other materials) will be removed from the road in a timely manner. Of course, all construction related fugitive dust emissions, on the overall basis, will be temporary and will cease to exist once construction is completed. Emission from open burning will be limited by removing materials whose burning would produce excessive smoke e.g., green vegetative materials. During construction there will be minor impacts on air quality. However, the proposed mitigation measures will reduce the impacts to an acceptable level, especially as they are limited to the construction phase. The overall construction period is expected to have duration of about 24 months The quantity of any emissions to be released during the construction process will generally be very low, but will vary on an hourly and daily basis as construction progresses

Extent of Impact on Air Quality = ▲ (Low) [with adoption of mitigation measures.]

5.4 SURFACE WATER

The nearest surface water is the irrigation canal. The existing surface water will not be affected by any construction activities. By avoiding uncontrolled discharges of liquids and waste, implementing adequate waste management and instigating appropriate organizational measures and mitigation

actions, impacts on surface water can be reduced to a low level and will be limited to the construction period.

Extent of Impact on Surface Water = ▲ (Low) [with adoption of mitigation measures.]

Groundwater

The proposed power plant site is located within the aquifer that serves the surrounding communities. Based upon the importance and sensitivity of this aquifer, as well as good construction practices, all precautions necessary will be required to reduce the potential for site impacts to a minimum.

While the proposed site preparation and facility construction activities for the power project are not anticipated to cause any short-term or long-term groundwater impacts to the site, Best Management Practices (BMP) will be employed during construction to ensure impacts (if any) are minimal and are properly mitigated

Fluctuations in groundwater levels are expected to occur throughout the year due to rainfall, by surface percolation and infiltration through the canal system. As a result, minor dewatering systems may be required and maintained during certain phases of construction (e.g., during engine foundation installation). After excavation, backfill, compaction, construction of the permanent plant drainage system and certain concrete construction activities are complete, the dewatering system, if required, will be removed. Any restoration needed for affected areas will follow after the dewatering equipment is removed. The implementation of appropriate erosion and sedimentation controls will also minimize adverse water quality impacts during site preparation.

Spills of fuel oil can have a potential adverse impact on soil, groundwater and particularly surface water during both the construction and operational phases of the project. During construction, all fueling will be conducted in a manner consistent with the spill prevention and response plan to be prepared by the construction contractor. During construction, fuel oil will be dispensed from tanks/drums to be located onsite to construction vehicles. Fuel for construction activities will be delivered to the site by fuel truck drivers, who will be required to receive spill plan training prior to beginning work. The trucks will be equipped with oil spill response materials. Each transfer will be documented. Implementing management controls should minimize the potential for adverse impacts due to spills during site construction.

During construction all contractors, technicians and laborers will be required to implement practices to minimize the potential for spills of fuels or chemicals. Maintenance will be performed only in designated areas. In the unlikely event that spills do occur, they will be managed in accordance with the project's Environmental Management Plan (EMP).

To further minimize potential environmental impacts it is recommended that full-time environmental monitoring is conducted during construction, particularly during all refueling operations to minimize

potential concern. The environmental monitoring could be under the environmental safety department, or a member of the safety department with the authority of "stopping the job" in the event that noncompliance of environmental regulation is being observed.

The proposed project includes the installation of supply tube-wells. The actual depths of the supply will be based upon the results of the geotechnical study and will take into account the occurrence of the local aquifer.

The wells must be designed to meet the necessary requirements for their intended industrial use and public safety. At a minimum, the wells should be properly grouted and cased to limit/reduce potential contaminants from impacting the upper freshwater lens

Extent of Impact on Ground Water = ▲ (Low) [with adoption of mitigation measures.]

Solid Waste

The major solid wastes to be generated during construction activities are:

- Bricks waste
- Waste from Quality Control
- Paper bags
- Used oil/lubricants
- Metal/wooden waste
- Medical waste
- Empty drums or containers
- Cotton rags
- Miscellaneous waste: Miscellaneous solid wastes include a host of items like• batteries, tires, tubes, filters, belts, nylon strips, scrap wood, steel scrap, house hold articles etc., which will be sold in the market through scrap dealers.

During the site clearance stage, it is anticipated that relative quantities of solid waste would be generated consisting of top-soil and sub-soil. The generation and disposal of site wastes is not considered to be a problem. Part of the excavated material would be used for leveling and grading and the balance would be stockpiled at designated locations on the site. Other solid wastes including, cooking waste and general solid waste are often associated with a relatively large workforces. Cooking wastes and general garbage will be collected at regular intervals and land filled at an approved disposal site. Sewage waste (construction type portable toilets) will be used, and waste properly disposed.

During trenching any construction waste not utilized as fill material during trenching activities should be removed from the route and properly disposed. The trenching route should be restored to its

original condition, prior to alteration by the project. In addition, all solid waste and surplus materials should be removed from the project site and properly disposed.

However, while disposing any waste material, all environmental aspects/impacts of such wastes should be communicated clearly to the concerned contractor. Record of all such sales should be maintained for later use if and when required.

Extent of Impact Due Solid Waste = ▲ (Low) [with adoption of mitigation measures.]

Noise Impact

Construction of the proposed project is expected to take place for about 24 months, with varying degrees of activity occurring during different phases of construction. Construction phases are expected to include excavation, concrete pouring, steel erection, mechanical/electrical installation and cleanup

Noise is generated by operation of heavy equipment and increased frequency of vehicular traffic in the area during construction activities. Vibration levels will also increase due to these activities. However, these impacts are short term, intermittent and temporary in nature and are not likely to be felt outside the boundary of the proposed project.

The exact noise levels are a complex function of variables such as the actual noise levels emitted from each major noise-emitting equipment, their location and orientation within the construction area, and their operation and load.

The adjoining localities are likely outside the range of impact of noise emissions due to construction activities. It is assumed that the relevant International and World Bank standards will be met

Overall, the impact of noise generated during construction on the environment is temporary and mainly confined to daylight hours. It is anticipated that it will be possible to reduce noise impacts during construction to an acceptable minimum.

Extent of Impact on Noise = ▲ (Low) [with adoption of mitigation measures.]

Fire Risk Fire and explosion hazard impacts are not expected during the construction phase due to the limited quantities of flammable and combustible materials to be imported to the site. The availability and use of portable extinguishing systems would limit the impacts of small fires, and personnel will receive training on the proper use and locations of this equipment. During construction, any waste disposal burning will be conducted in a cleared and dedicated area under controlled conditions, on those days when ambient air conditions will not permit embers to drift into the surroundings.

5.5 ECOLOGICAL IMPACTS

Terrestrial Systems

During construction activities, land clearing is a necessary component of the proposed development activity. Land clearing, as proposed, will be limited to the just required limits for the needs of the project, and will be conducted in such a manner that is protective of the environment.

Fauna and Flora

Site preparation for the plant does not require any clearing of vegetation but ground excavation will be necessary.

The construction area is not perceived as including sensitive habitats. Under normal dry weather conditions, a significant amount of dust will be thrown up by excavating activities. Hence, vegetation and animal habitats in the vicinity of the site and roads will be affected by wind-blown dust and its deposition. The contribution to the natural dust concentration in the air will only be of significance at the beginning of the construction phase, during the main excavation activities. During this period, dust can be expected to settle on plant leaves and aerial roots, which could hinder air exchange and assimilation by the plants.

The temporarily increased vehicular traffic coupled with high noise levels due to various construction activities may also have some negative impacts on animals. Especially birds and other acoustically orientated animals living in the vicinity of the site and the roads used can be disturbed by noise. Disturbances during the period of construction could drive noise sensitive bird species from their habitats, but these are expected to return after construction has finished. No endangered species were found in the construction area.

During the visual inspections of the site no nests or nesting was observed. No birds or wild animals were discerned in the site vicinity. Accordingly, during the construction phase of the project, birds would likely relocate to undisturbed areas.

The influence of dust is unavoidable but mainly restricted to the first period of the construction phase. No major impacts by dust and noise on the flora and fauna in the vicinity of the site and the used roads are to be expected.

The construction related impacts on offshore fauna and flora may be considered to be low.

Extent of Impact on Fauna & Flora = ▲ (Low) [with adoption of mitigation measures.]

Impacts on Human Population Construction related noise is not anticipated to be a significant concern to the nearest receptor outside the project site boundaries. The construction activity will normally occur during daylight hours and will run one shift per day. In addition, any excessive noise generated

by construction related activities will be short term and short duration, and will generally not exceed the World Bank noise guidelines.

However, there might be a notable increase in road traffic as freight is moving to the site. No direct impacts to the communities or neighborhoods are anticipated.

Based upon visual inspection of the site and site vicinity, the proposed power plant site and roadway are absent of any residences. As a result, no relocation impacts are anticipated

Traffic Impact

It should be anticipated that an overall increase in traffic would occur directly as a consequence of the proposed construction. An increase in traffic will occur to and from the project site subsequent to freight arrival. The temporary traffic impacts are not expected to affect significantly the local residents since residential development is sparse in the immediate site vicinity. No significant traffic problems are expected during the construction period, other than minimal delays for start and stop time for the workers commuting to their residences and due to occasional heavy equipment and materials moving to and from the site. Construction traffic generation should be viewed at the most as a temporary inconvenience.

5.6 SOCIO-ECONOMIC IMPACTS

Most of construction workers are anticipated to be hired from within the nearby area where the project site is located. In addition, general contractors/vendors, consultants and engineers from within the country will provide technical and specialized services. The construction impacts on the local employment opportunities are beneficial, although relatively short term. Indirect employment in the local area will also occur primarily in retail, eating and drinking establishments.

During construction of the plant employment opportunities will be created both for skilled and unskilled local workers.

Extent of Socio-Economic Impact = ▼▼ (locally favorable)

Public Services and Facilities

Construction related impacts to public services and facilities, such as police, fire, and medical services and water, wastewater and solid waste disposal are not expected to be significant. With minimal relocations to the project area expected, existing facilities and services will be adequate to meet the demands on these services. The selected general contractor will be responsible for removing and disposing of construction related debris.

Cultural Resource Impacts Fugitive dust emissions will be properly controlled so that minimal impact on visibility will occur. Also as discussed earlier, due to attenuation with distance, construction noise will not affect the quality of life at the nearest habitats. Some minor inconvenience may occur through

increased traffic and equipment creating conflicts on N 120 Hyderabad to Tando Allahyar road. However, during construction of the power plant, no conflicts are anticipated with cultural resources in the area

5.7 ENVIRONMENTAL IMPACTS ASSESSMENT DURING OPERATION PHASE

This section discusses the potential impacts from regular operation of the proposed power plant and associated facilities on the natural resources and environment of the site and vicinity. Power plants invariably have potential for environmental impacts during the operational phase of the project. During the operational phase the following impacts are normally of significance

Air quality impacts

Ecological impacts

- Impacts associated with the abstraction and discharge of water
- Impacts arising from solid waste management
- Noise and vibration impacts
- Soil, groundwater and surface water contamination
- Accidents/explosions
- Socio economic impacts

For the purpose of evaluating the impacts from the proposed project, Sindh Environmental Quality Standards (SEQS) Pakistan and the World Bank/IFC standards are used. National Environmental Quality Standards (NEQS) Pakistan are presented in Annexure.

Air Quality Impacts

The combustion of fuels for power generation inevitably results in emission of gaseous pollutants to the atmosphere. The pollutants of potential concern are sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide (CO_2) and particulate matter (PM).

In general, the most significant emissions from the combustion in boilers of the proposed project are oxides of nitrogen (NOx), carbon dioxide (CO_2) and particulate matter. Smoke and carbon monoxide (CO) are much less problematic as developments aimed at improving combustion efficiency in the boilers have also addressed these pollutants

5.8 ECOLOGICAL IMPACTS

Impacts on Fauna and Flora

Air Emissions:

The effect of air emissions from the stacks upon breeding birds (if any) proximal to the site will not be clear without careful monitoring. During the preparation of the EIA, no nest or nesting birds were observed on or proximal to the project site. Recommendations for a monitoring program include review of areas immediately adjacent and proximal to the site. Since birds are generally mobile, it is

anticipated that they will relocate beyond the sphere of influence of the plant.The affect of gaseous and PM emissions on the adjacent areas, after adoption of necessary mitigation measures, is not anticipated to be a concern.

Noise:

Noise from the operation of the proposed project, after adoption of necessary measures, will result in its level not exceeding the limits set by the WB. Thus, noise from the project activity will not give rise to any serious adverse impacts on the surrounding fauna and flora

Waste Water:

Liquid effluents from all sources including also sewage to be generated in the power plant will be treated according to required levels of the Sindh Environmental Quality Standards as well as those by the World Bank, before discharging into the nearby water canal, after due permission from the competent authority.. Process for getting permission has already been initiated.

Accordingly, there is no question of any adverse impacts from waste water to fauna and flora.

Extent of Impact on Fauna & Flora = ▲ (Low)

Landscaping

At the completion of construction activities, landscaping should include the abundant use of native plant species. After completion of construction phase, the site will be mostly dominated by buildings, plant & machinery, stacks and storage tanks. Within this area of low visual impact, the additional visual intrusion due to realization of the project may be assessed as low.

Extent of Impact of Landscape = ▲ (Low)

Supply of Water

The project plans to install tube-wells within the plant boundary. The production rate, concomitant drawdown and the resultant radius of influence from the new wells should be evaluated to confirm no detrimental impacts are caused by the production capacity of the new wells. It is recommended that monitoring of the influence of the withdrawals from the newly installed wells should also be conducted. Measurements should include:

- Baseline water quality data are available from the existing MSML tube-wells to evaluate the water quality in the vicinity of the plant.
- Subsequent to groundwater withdrawals, additional water quality data should be collected initially at startup of the production well, and subsequently at a frequency that will enable measuring any small changes in water quality, e.g., increases in chlorides, to be observed.
- Depth to water measurements to observe whether there has been a reduction in ground water levels that results in movement of the freshwater lens/salt water interface.

- Noting whether induced movement or induction of pollutants into the water supply is occurring resulting in a significant reduction in water quality.
- Monitoring data should be able to confirm whether there have been any detrimental impacts to the well field water quality.

Extent of Water Supply Impact = ▲ (Low) [with adoption of mitigation and monitoring measures proposed.]

5.9 SOLID WASTE MANAGEMENT

The types, sources, and management of solid wastes anticipated to be generated during the operation of the proposed project facilities are as follows:

Plant wastes such as office wastes, packaging materials, garbage, refuse, redundant electric gadgets, various types of wastes of a large variety and rubbish/trash will be generated during the operational phase of the proposed project in addition to general solid waste. According to nature of solid waste, some of these will be recycled, burnt/incinerated on the site while others will be sold in the market through an approved contractor while keeping all the records. The contractor will be fully briefed /educated about the nature of the wastes. Other plant wastes, such as lead acid batteries will be segregated from other waste streams, collected and stored in suitable containers, and if not incinerated will be transported off-site and disposed at an approved land fill site by an approved waste transporter and contractor.

Special wastes such as hazardous waste, industrial solvents and other chemical wastes, and used oil, will be generated during the operational phases of the proposed project. Special wastes could also include items such as waste oils, waste lubricants, paints, maintenance-related wastes, used air and liquid filtration media, and empty or nearly empty chemical containers. Most, if not all, of these materials will be disposed of by incineration. While others will be sold in the market through an approved contractor and informing the contractor of their hazards and rational use. Sludge from sewage and wastewater treatment plant, after due treatment, will be used as manure for vegetation, trees etc.

Ash Handling

The project will produce bagasse. To minimize the impact on the environment and maximize value creation, the power plant will implement an ash utilization plan. Ash will be handled in dry form and directly loaded into enclosed trucks of the end users through ash silos.

Extent of Impact of Solid Waste = ▲ (Low) [with adoption of mitigation measures proposed.]

Noise & Vibration Impacts

Once operational, additional ambient noises may be of concern, however, package systems are noted for the quietness of their operation, and according to the project feasibility prepared, ambient noise

measurements of the equipment/machinery will be designed to operate with a total noise level not exceeding85 to 90 dB (A) in the very near vicinity of the machinery. While at the property boundary, the noise level is expected to be less than 70 dB(A) as against the limiting value of 70 dB (A) by the SEPA/WB for industrial areas. Therefore, in case the built in design of the plant achieves these noise levels then no excessive ambient noise impacts are anticipated at the receptors especially the human settlements near to the project site.

Extent of Impact on Noise Level = ▲ (Low) [with adoption of mitigation and control measures.]

Soil and Surface Water & Ground Water Contamination

A major operational concern of any chemicals transfer operation is the control, containment and efficient cleanup of any discharges or spills during transfer. To this end, spill mitigation supplies including hoses, a boom of sufficient length, and absorbent materials should be located at the chemicals unloading station. In addition, as part of the transfer operation policy, each transfer should only proceed in the presence of a plant operator, who has deemed the fitting between the transfer hose and pipe to be secure. The absence of any mitigation equipment in the immediate vicinity of the transfer operation can have potentially disastrous environmental consequences for the ecosystem. In the event of a spill/discharge, the spill should be contained and not permitted to discharge to the adjacent surface water body.

To this end, spill mitigation equipment should be located at the transfer station, to enable a rapid response to control the movement of any discharged chemical. Design of drainage systems, both within and outside process buildings, should take account of the need to segregate spillages of hazardous materials. Drains systems to be considered may include sewers, storm water drains, process effluent systems and firewater drainage systems.

In many cases these functions are combined and often firewater and process effluents are drained into main sewerage systems. Where there is a possibility that hazardous substances could be discharged into a drainage system, interceptors or sumps should be provided of sufficient capacity to ensure that an offsite major accident does not occur.

For process effluents arising from leaks or plant wash down, good practice is to provide a local sump, which is sampled before emptying. Such sumps normally incorporate level indicators/alarms for monitoring. Discharge can be to drums via submersible or mobile pumps for onward disposal or via manual or manually operated automatic valves into main drainage systems, if the contents are non-hazardous. As for drainage following a storm event, consideration will need to be given for the possibility of valves being left open.

A particular concern is the discharge of non-water miscible flammable liquids, which form a top layer. These could ignite at considerable distances from the plant after discharge. More sophisticated interceptors can be provided to facilitate removal of floating flammable liquids. These tend to be

designed to meet individual needs and may incorporate conductivity-based level sensors to distinguish between layers.

Impacts on the soil quality could be caused by deposition of NO_X in the soil. Normally, a distinction is made between wet and dry deposition, with wet deposition having considerably more impact, as air pollutants are effectively scrubbed out by the precipitation. Because the amount of rainfall is relatively low, wet deposition can be neglected. It is not anticipated that deposition of NO_X in the soil will have any significant negative impact.

Extent of Impact = ▲ (Low) [with adoption of mitigation measures.]

5.10 SOCIETAL IMPACTS DURING OPERATIONS

Neighborhood and Communities

Few human settlements are present with in the distance of about 0.5 to 2 kilometers (KM) from the project boundary line, of which Goth Saleh Halepoto has a total population of about 8, 000 to 10, 000 is hardly about 1.5 km away from the proposed power project site. Out of these seven villages, with the exception of one or two, none of these has any health facility or adequate drinking water supply. Education facilities are not adequate.

Extent of Impact = ▲ (Low after strict compliance with the required environmental management systems)

Relocation Impact

As mentioned earlier, since relocation will not be required during implementation of the project, no impacts are anticipated in the project area of influence during operation phase.

Extent of Impact = ▲ (Low)

Traffic Impact

The use of local roads is not anticipated as a direct consequence of the operation of the power plant. There will be no increase in local road use is anticipated during peak hours and between changing operator shifts. Additionally based upon the remote location of the site, no concerns are anticipated with respect to increased traffic activity.

Extent of Impact = ▲ (Low) [with adoption of mitigation measures.]

Economic Impact

The establishment of the Mehran Energy Ltd. cogeneration power plant will provide new jobs at the plant site. Most people of the area make their living directly or indirectly from agriculture and cottage industry. Short-term economic benefit will be realized by providing janitorial services, horticultural services, loading/unloading workers, canteen, and semi-skilled &some skilled activities, as well as by increased use of available rental property.

Long-term benefits will include indirect employment, as a result of improved and reliable electricity and other economic benefits provided by increased and reliable supply of electricity. As a result, continued operation of the proposed plant will generate revenue into the Country's economy and the region.

The installed electricity capacity is insufficient to meet current and near future demand for power. Without additional capacity, the need for load shedding becomes likely in order to maintain a balance between demand and generation capacity. Therefore, the proposed project is designed to add to the current and future needs providing reliable additional electricity generation capacity. There are no negative or detrimental potential impacts on the socio-economic setting of the area arising as a result of the proposed project. As such no mitigation measures are required.

Extent of Socio-Economic Impact = ▼▼ (locally favorable)

5.11 ENVIRONMENTAL ASPECTS, IMPACTS AND MITIGATION

#	Environmental Issue	Aspect	Impact	Mitigation
1	Surface water quantity & quality	Abstraction of water for steam generation Discharge of effluent	Increased water abstraction from the river during construction and start of operation Increased downstream flow due to reduced overall volume of water abstracted from the river for steam generation once operations of the project stabilizes No quality impact due to waste treatment	The contractor should put measures in place to ensure water conservation during construction activities Project reduces water demand for steam generation Continue to monitor treated waste quality before discharge to the river
2	Air quality	Flue gasses and particulate matter	Presence of particulate matter in the air can cause bronchial and asthmatic conditions to workers and people living within the area Presence of greenhouses gases such as carbon dioxide and methane which is released through combustion of bagasse increases the global warming conditions	Removal of particulate matter from the exhaust using electrostatic precipitator and ensuring that the precipitators operates effectively always Reduction of greenhouse gases emission into the atmosphere from decomposition of bagasse which is dumped in the sugarcane field and fossil fuel burned in thermal plants. A carbon neutral project.
3	Soil	Ash generation and disposal	Possible water & soil pollution if the ash is not handled carefully during collection and disposal	Effective collection, storage and controlled application of the ash in the plantations.
4	Health and safety	Occupational hazard	Destruction of property Accidents and injuries to worker during construction and operation of the project Fire outbreak Increased noise levels from construction equipment	Identification and elimination of potential hazards Provision and use of appropriate and adequate personal protective equipment. Ensuring contractor compliance Provision of adequate firefighting equipment and

				emergency procedures as is currently the case
5	Socioeconomic impacts	Increased incomes from project activities	Increasing employment opportunities for the local community Increased revenue generation for the company which eventually trickles down to farmers and workers Reduction of health effects caused by presence of particulate matter in the air	The company should continue with diversification programme so as to increase the revenue generation and economic development. (See attached minutes of the stakeholders' meeting on the project in Annex 1 below).
6	Resource conservation	Use of clean technology	Use of ash for soil pH stabilization eliminates the need for artificial fertilizers Water conservation due to reduced water consumption Use of renewable resources for electricity generation reduces the pressure of fossil fuels and vegetation	Putting measures in place to ensure that operational procedures are followed always and identification of nonconformity identified and addressed

Environmental Management Plan

Item No.	Environmental Issue	Impacts	Proposed Action	Implementation Time frames	Responsibility	General Remarks
1	Water Quality Issues	Increased water abstraction from the canal during construction	Putting measures in place to ensure water conservation during construction activities Minimum excavation be done at the site to reduce soil disturbance during construction, Liners should also be laid down where cement and other substances are mixed for	During construction and operation	Contractor	Water conservation will ensure that downstream flow is increased and water pollution from construction activities does not occur

			easy collection and cleanup after operations.			
2	Air Quality	Presence of particulate matter in the air can cause bronchial and asthmatic conditions to workers and people living within the area Release of greenhouses gases such as carbon dioxide and methane due to combustion of bagasse increases the global warming conditions	The design to incorporate an electrostatic precipitator in the boilers to remove particulate matter, Provide appropriate personal protective equipment where necessary and enforcement on their application at all times.	During construction and during operation	Contractor	Removal of particulate matter and ash will ensure that that health of the workers and individuals living in the area will not be affected
3	Soil	Possible water pollution if the ash is not handled carefully during collection and disposal	Dry ash extracted be stored in a heap surrounded by a mound to prevent surface runoff from washing it down to the river, Periodic removal of the ash and application in the field Transportation of the ash to the field should be done carefully so that the ash is not dispersed along the way	During construction and operation	Contractor	This will ensure that the ash disposal system does not lead to water pollution
4	Health & Safety	Destruction of property Accidents and injuries to	Initiate characterization of wastes and segregation of the same	During construction and	Contractor	Ensure application of PPEs, and

		worker during construction and operation of the project Fire outbreak	during construction, Ensure that workers are provided with personal protective equipment and their usage is enforced Adequate firefighting equipment and all the employees working in the generation plant shall receive training and education on matters relating to EHS to ensure effective EHS performance and continuous improvement in the same A first Aid Kit should be maintained in the site and should be stocked with basic medicines such as pain relievers, bandages etc. to cater for minor injuries, Observance of good and safe construction site practices During operation, all workers should adhere to laid down EHS procedures continuously	during operation		internal waste handling procedures and ensure that the procedures are adhering to.
5	Socioeconomic issues	Employment opportunities for the local community, Contribution to national economy.	Continue with what is in place in order to ensure sustainability	Continuous	Proponent	Ensure that maximum opportunities should be provided

						to locals.
	Resource conservation	Use of ash for soil pH stabilization eliminates the need for artificial fertilizers Water conservation due to reduced water consumption Use of renewable resources for electricity generation reduces the pressure of fossil fuels and vegetation	Putting measures in place to ensure that operational procedures are followed always and identification of non-conformity identified and addressed	Continuous		Reduction of natural resource consumption which is beneficial to the country
7	Compliance Aspects	Compliance with the legal requirements, market demands and ethical obligations.	Carry out annual environmental audits as required by law, Review all contractual agreements to reflect the environmental legal requirements Review a corporate environmental policy guideline, Obtain necessary water abstraction permit for the additional water abstraction.	Continuous	Proponent	A regular monitoring ensure compliance with laid down guidelines at all times, Obtain necessary permits where required, e.g. Water abstraction permit.

5.12 CONCLUSION

- The results of this study show that the proposed Mehran Energy Limited Cogeneration project does not have a potential for serious negative environmental impacts. The project is siting within an existing factory and the specific area already has a suitable foundation built.
- The project uses renewable waste to produce energy in Pakistan where at least 50% of the energy is hydro based and very susceptible to weather patterns. The other potion is significantly fossil fuel based thermal energy which is prone to exchange fluctuations and other political instability in certain regions of the world. Energy source diversification is therefore very beneficial to the whole country.
- The potential adverse environmental impacts such as ash, wastewater and particulate matter in flue gases have been adequately mitigated. Plans are also in place to adequately mitigate the health and safety impacts of the project.
- From a socio-economic point of view, the project has significant economic benefits not only to the community but also to the whole country.
- The recommendations have been provided in the Environmental management Plan as proposed actions.

5.13 IMPACT PREDICTION AND EVALUATION

The Most Important Environmental Impacts

Important environmental impacts are air and noise emissions caused by any transportation measure. Trucks and cranes carrying materials such as equipment, fish waste, fish oil, methanol and biodiesel cause noise emissions and emissions into the air by waste gas of their combustion engines. The magnitude of these emissions is negligible especially when compared to the alternative solutions. These emissions (except emissions occurring during construction and reconstruction work) anyway occur. In total the project has the potential to minimize these emissions because the holistic solution of treating the waste and converting it to locally needed energy would reduce transportation.

The EIA Matrix

Deduction of EIA Matrix

All identified and relevant environmental impacts are summarized and assessed within the next tables. These are the preceding tables of the EIA Matrix.

The Matrixes are filled by use of the following criteria and scores.

Phase of impact occurrence:

1) Construction / implementation phase
2) Operation and maintenance phase

Magnitude of change / effect

1) Change / effect only within the project site

2) Change / effect to local conditions and / or to areas immediately outside
3) Regional / national / international change / effect
+) indicating beneficial impact

Permanence of impact

(1) No change / not applicable
(2) Temporary
(3) Permanent

Reversibility of impact

(1) No change / not applicable
(2) Reversible
(3) Irreversible

Extent the impact is cumulative

(1) No change / not applicable
(2) Non-cumulative / single
(3) Cumulative (+) indicating beneficial impact

Table 5.2: Preceding EIA Matrix

Phase of impact occurrence:		(i) construction / implementation phase			
		Magnitude of impact	Permanence of impact	Reversibility of impacts	cumulative effects
Location	Impact				
Plant site	Noise emissions	(1)	(2)	(1)	(1)
Plant site	Air emissions	(1)	(2)	(1)	(1)
Plant site and surroundings	Emissions due to transport	(2)	(2)	(1)	(1)

Table 5.3: Preceding EIA Matrix

Phase of impact occurrence:		(ii) operation production and maintenance phase			
		Magnitude of impact	Permanence of impact	Reversibility of impacts	cumulative effects
Location	Impact				
Plant site	Noise emissions	(1)	(2)	(1)	(1)
Plant site	Air emissions	(1)	(2)	(1)	(1)
Plant site and	Emissions due	(2)+	(2)	(1)	(1)

surroundings	to transport				
Plant site	Spilling of fuel	(1)	(2)	(2) - -(3)	(1)

Within the following EIA/IEE matrix a summarization of the existing and occurring environmental impacts will be given. In comparison to the preceding EIA/IEE matrix tables, the following summarizing table additionally contains an assessment figure which is calculated by the following formula:

- Magnitude of impact
- Permanence of impact
- Reversibility of impact
- Cumulative effects

Wherever a (+) is stated, the respective figure is not added but subtracted from the sum. Wherever the given figure is not a unique number but a range, for the calculation the average of that range will be taken into account.

Location	Impact	Phase of impact occurrence	Magnitude of impacts	Permanence of impact	Reversibility of impacts	cumulative effects	Assessment sum
Plant site	Noise emissions	(i) (ii) (iii)	(1) (1) (1)	(2) (2) (2)	(1) (1) (1)	(1) (1) (1)	5 5 5 Ø 5
Plant site	Air emissions	(i) (ii) (iii)	(1) (1) (1)	(2) (2) (2)	(1) (1) (1)	(1) (1) (1)	5 5 5 Ø 5
Plant site and surroundings	Emissions due to transport	(i) (ii) (iii)	(1) (1) (1)	(2) (2) (+) (2)	(1) (1) (1)	(1) (1) (1)	6 2 6 Ø 5
Plant site	Spilling of fuel	(ii)	(1)	(2)	(2)-(3)	(1)	6,5

5.14 IMPACT ASSESSMENT

The previous table shows the environmental impacts. In general it can be stated, that the environmental impact the project causes is comparatively small (no score above 10). The maximum

score it 7, 5 and this is only a theoretical impact in case of an accident. Taking accidental events out of consideration, than the maximum impact scores it 6. This score reflects additional emissions (noise and air) due to transportation measures caused by the construction and deconstruction phase respectively. The amount of these additional emissions is very small.

Chapter 6

ENVIRONMENTAL MANAGEMENT PLAN

6.1 MITIGATION

The mitigation measures for the construction and operational phases are summarized in Tables 6.1 and 6.2, respectively. These tables identify mitigation measures that should be implemented to minimize the predicted effect of each activity. All facets of the mitigation plan is included as good engineering practices and best management practices, and is therefore already included in the current project cost.

6.2 CONSTRUCTION PHASE MITIGATION

Activity	Potential Impact	Mitigation measures	Mitigation measures
Site Work – Clearing and Grading	Loss of Dried shrubs and wild growth	There are few trees that are potentially affected by the Site work. No trees should be cut that do not interfere with the site work. The wood that is cleared will be made available to local residents	Contractor
Site Work – Clearing and Grading	Interference with Natural Site Drainage – Soil Erosion	Final site grade will facilitate drainage and avoid flooding and pooling. A site drainage plan will be developed that protects against erosion. Protecting stockpiles through the use of silt fencing and reduced slope angles will also minimize soil erosion during construction.	Contractor
Site Work – Clearing and Grading	Noise from Equipment	Construction equipment shall meet the applicable standard in EU Directive 2000/14/EC of May 2000. This Directive applies to the manufacturer of the noise emitting equipment. Work involving nuisance noise should be minimized during locally recognized days of rest and at night. All equipment	Contractor

		should be maintained in good working order.	
Site Access Upgrades - Roadwork	Dust and Noise from Equipment	Watering of disturbed site areas on an as needed basis will minimize dust. No equipment noise should exceed the applicable standard in EU Directive 2000/14/EC of May 2000. This Directive applies to the manufacturer of the noise emitting equipment. Work involving nuisance noise should be minimized during locally recognized days of rest and at night. All equipment should be maintained in good working order.	Contractor
Dewatering	Sediment and Oil and Grease loading to Nearby Waterways		Contractor
Borrow Site	Conflicts with Present Land Use	Borrow area should avoid agricultural areas	Contractor
Borrow Site	Disturbance to Local Community	All permits and approvals should be obtained from the appropriate authority prior to operating a borrow site	Contractor
Borrow Site	Unsightly Area Finished with Borrow Activity	Borrow areas should be reworked to blend into the surroundings. Re-vegetation should be performed using local plants. All slopes and working faces should be returned to a stable condition.	Contractor
Disposal of Excavated Material if Necessary	Interference to Natural Drainage	The amount of material to be disposed of should be minimized by borrowing only as much as is needed	Contractor
Disposal of Excavated Material if Necessary	Disturbance to Land	Local authorities should approve the disposal site. It should not interfere with local land use. Vegetation should be performed using local plants. All slopes at a borrow disposal site should be graded to a stable condition.	Contractor

Transmission Interconnection	Disturbance to Land	The amount of land used for the transmission interconnection should be minimized. No agricultural lands should be disturbed by the transmission line. Private land acquisition should follow the procedures that are based on Law No. 8561, dated 12/22/99; Government Decree No. 126, dated 3/23/00; Government Decree No. 127, dated 3/23/03; Government Decree No. 138, dated 3/23/03; Government Decree No. 147, dated 3/31/00.	Contractor
Provision of Potable Water	Reduced Water Supply to Area Residence	The water supply for use in construction of the generation facility must be monitored to ensure that it does not adversely affect other water uses in the area.	Contractor
Storage of Fuels and Hazardous Materials	Potential Health and Safety Concerns	All employees should undergo health and safety training. Those dealing with hazardous materials should receive specific training in handling the materials. There will be no ash generated from the oil combustion. Hazardous waste generated will primarily be from waster lubricants and rags from clean-up and maintenance activity.	Contractor
Handling and Storage of Fuels and Hazardous Materials	Soil and Water Contamination from Spills	Fuel storage tanks will have secondary containment with sufficient volume to contain a spill from the largest tank in the containment structure. The containment area will have a means of removing accumulated water. Drains will be routed through the site oil/water separator. A spill and emergency response plan will be developed and put in place prior to commencement of construction	Contractor
Aggregate	Reduced Local	No new sources should be developed.	Contractor

Source	Resources	Existing quarries will be utilized	
Batch Plant – Concrete and Asphalt	Noise, Dust, and Potential Runoff Concerns	Storm water runoff should be directed to the site drainage system. Noise should be controlled to an acceptable level. Dust bags should be installed as necessary. The nepra specification will require that the batch plant owner/operator must hold valid operating permits.	Contractor
Construction Work Force	Influx of Workers Creating Pressure on Housing and Other Resources	Influx of workers is not expected to exceed 350 to 500individuals. Workers will be housed in Vlorë and bussed to the Site. A first aid station will be provided for workers onsite	Contractor
Delivery of Equipment and Materials	Increased Traffic and Dust	Upgrade of the main access road to plant will have positive effect on local traffic. Dust from the road should be minimized with water during construction and by providing paved surface. Trucks should be tarped when carrying load. Road speeds should be controlled to reduce the potential for accidents.	Contractor
Solid Waste Disposal	Potential Health Concerns	Solid waste should be disposed as per SEPA directions and hazardous solid waste should be disposed through SEPA licensed contractor of using a licensed contractor	Contractor
Liquid Waste Disposal	Potential Water Contamination	A packaged sewage treatment facility will be provided for the site. No direct discharge of untreated liquid waste will be allowed	Contractor
Construction	Disturbance of Aquatic Resources	Main mitigation is in siting the exact location of the intake and outfall. Construction wastes will not be disposed of in the bay. Intake design should follow the USEPA Draft Guidance for Evaluating Adverse Impact of Cooling Water Structures on	Contractor

		the Aquatic Environment and the European Commission IPPC reference Document on the Best Available Techniques for Industrial Cooling Systems.	
Final Site	Aesthetics	Topsoil will be graded and planted as appropriate	

6.3 OPERATION PHASE MITIGATION

Activity	Potential Impact	Mitigation measures	Mitigation measures
Equipment Operation	Noise from Equipment	The combustion turbines will be enclosed in an acoustic enclosure to ensure that noise does not exceed 85 dB(A) at 1 m. Workers in close proximity to this equipment should be required to use hearing protection. Offsite noise will not exceed 70 dB(A).There is no residential housing in the area of the site	Contractor
Cooling Water Intake	Impingement of adult and juvenile fish and shellfish		
Cooling Water Discharge	Thermal effects on marine fauna	Thermal discharge modeling demonstrates that the thermal impact from the discharge is less than or equal to 3 ^{o}C after mixing zone. This ensures that there is minimal impact from the discharge. The discharge should be designed to minimize or eliminate re-suspension of sediment in the vicinity of the outfall	
Fresh Water Supply	Reduce water supply to the local community	The plant will supply its own service water supply from the Adriatic Sea through a membrane desalinization system .	
Sewage Treatment	Discharge of nutrients and other contaminants to waterways	A sewage treatment facility will be provided at the plant and discharge of treated effluent will be combined with the cooling water discharge.	
Local	Stress on the local	The infrastructure of the city of Vlorë will	

Community Services	infrastructure	be able to accommodate the amount of new residence of new workers in the plant even if all workers come from outside the city. However, it is anticipated that many of these workers will be from the Vlorë area.	
Handling and Storage of Fuels and Hazardous Materials	Delivery of fuel oil could result in a spill that would impact the aquatic and coastal environment	A spill response plan and necessary response equipment should be provided. It is anticipated that as many as 30 deliveries will be made per year. Monitoring and enforcement of sea conditions under which a vessel may make deliveries should be part of the plant procedures and implemented through the delivery contract	
Handling and Storage of Fuels and Hazardous Materials	Pipeline between the terminal and the site could rupture and impact the aquatic and coastal environment	The pipeline should be regularly inspected and maintained. An inspection and maintenance program should be developed as part of the plant operating procedures.	
Handling and Storage of Fuels and Hazardous Materials	Oil storage tanks could fail and result in adverse impacts on the soil and groundwater resources	Oil storage tanks will include secondary containment of sufficient size to contain 110% of the contents of the largest tank. A means of removing rainwater will be included. Drains will be routed through the plant oil/water separator	
Transmission of Power	Disturbance to Land	Clearing for transmission lines should be minimized. Lines should be routed to minimize the impact on residential areas. The electromagnetic field (EMF) emitted by the line will be checked.	
Aesthetics	Aesthetically displeasing appearance may affect the tourist appeal of the coast	Some disruption is unavoidable. The plant will be shielded by trees and set back from the ocean. Landscaping will be used to enhance the appearance of the generation facility	

The major environmental concerns requiring mitigation, arising from construction and operation of the proposed plant, can be grouped into three areas:

- Air emissions
- Social requirements

6.4 AIR EMISSIONS

Main part of bagasse is carbon and oxygen. There are small amounts of nitrogen (1.82%) and sulfur (less than 1%) in bagasse. This combined with the fact that combustion temperature is low, results in low SO_2 and NO_2formation. Thus, the $S0_2$emissions of the bagasse power plant are much lesser than the coal and oil-fired power plants. However, even though about 76% of the electricity is produced from the natural gas, the SO_2emissions from the bagasse power plant are lesser than the combined electricity production from all the three types of conventional fuel plants. For the case of NO_2, the emissions from the bagasse power plants are much lesser than all the three types of conventional fuel plants. It must also be pointed out than even though the conventional fuel power plants have facilities for SO_2 and NO_2 removal whereas the bagasse power plants does not, the emission of these gases are lower for the latter. Since both SO_2 and NO_2 contribute to acidification and NO_2 also contributes to photochemical ozone formation, these impacts will be mitigated.

Since the $C0_2$ from the bagasse combustion can be recycled in photosynthesis during the growth of sugar cane, this emission does not contribute to global warming. This is a clear advantage of the bagasse power plant since thereare substantial emissions of CO_2 from all the other type of conventional fuel plants.

Total suspended particulates (TSP) are also emitted in much higher amounts as compared to the conventional power plants. Particulate matter in bagasse fired boilers is caused by the turbulent movement of combustion gases with respect to the burning bagasse and resultant ash. Soil (from cane) characteristics such as particle size can affect the magnitude of particulate matter emitted from the boiler. Cane that is improperly washed or incorrectly prepared can also influence the bagasse ash content. These may be possible reason for the high emission of TSP. Also, the RSFPP has only multi-cyclone for pretreatment of flue gas before releasing to the atmosphere. Adding other dust removal equipment such as electrostatic Precipitator (ESP) would reduce TSP emitted from the stack.

Overall, bagasse may be friendlier for the environment impact than fossil fuels as discussed above. However, the issues of improving combustion and dust removal need to be addressed to realize the potential adequately.

The best available technology for controlling air emissions will be used at the Generation Facility in order to meet applicable air quality and emission control standards. The combustion turbines will employ good combustion control and water injection technology to control the emission of nitrogen

oxides (NOx). In addition, the combustion turbines will also use good combustion control to reduce emissions of carbon monoxide (CO).

Water Environment

- Water control measures shall be undertaken.
- No trade effluent shall be discharged from the Plants.
- Cooling water is put into closed circuit to minimize the evaporation losses.
- The domestic sewages from the Plants, Power Plant and Township shall be treated in the proposed
- No percolation of treated water to the deep ground water table is done.
- Periodical monitoring for specific parameters shall be done regularly

6.5 SOCIAL REQUIREMENTS

Loss of Land

The land to be used for the generation facility is currently owned by the Mehran Energy Limted before that it was a property owned by Mehran Sugar Mills.. There are no issues with displacement of residence or land use.

Influx of Non-Local Workers

It is expected that most of the construction work force will be from the project area, while the remainder will be from other parts of the province.. It is not anticipated that an influx of workers to support the project will put excessive pressure on the existing social services. The construction supervisory staff will not likely be local and will be temporarily housed in temporary shelter near the project area.

Residual Impacts after Mitigation

There will be some unavoidable impacts that cannot be completely mitigated. These include the following:

- Air emissions
- Visual appearance of area
- Potential for new housing and permanent population of up to 20 families

6.6 MONITORING

The monitoring program will be used to verify that predictions of environmental impacts, developed in the design phase, are accurate and that unforeseen impacts are detected at an early stage. This allows corrective measures to be implemented before significant damage has taken place. Monitoring programs for each of the major environmental components are identified and defined in separate

sections below, it is necessary that one agency or individual maintain a coordinating role to oversee and report on the outcome of all the studies.

Preconstruction

No preconstruction monitoring will be done. Monitoring will be part of the plant construction and operation.

Construction

Each of the parameters identified in the construction mitigation plan will be monitored during construction. Table 6.3 identifies the monitoring parameters and responsibilities during construction. More specific information is given for various monitoring later in this section.

Table 6.3: Monitoring Plan for Construction

Activity	Monitored Parameters	Responsibility
Site Work Clearing and Grading	Site Work – Clearing and Grading	Contactor
Site Work – Clearing and Grading	Protecting stockpiles through the use of silt fencing and reduced slope angles to minimize soil erosion during construction should be monitored to ensure that the practice conforms to site drainage plan	Contactor
Site Work Clearing and Grading		Contactor
Site Access Upgrades – Roadwork		Contactor
Dewatering	Maintain a record of visual inspection of excess water from dewatering activity	Contactor
Borrow Site	Monitor and document that borrow areas avoid agricultural areas	Contactor
Borrow Site	Obtain and maintain applicable permits	Contactor
Borrow Site	Document final condition of borrow areas to ensure that they have been reworked to blend into the surroundings and are safe	Contactor
Disposal of Excavated Material if Necessary	Monitor and document the use of borrow material	Contactor
Disposal of	Obtain and maintain applicable permits. Document	Contactor

Excavated Material if Necessary	final condition of borrow areas to ensure that they have been reworked to blend into the surroundings and are safe	
Transmission Interconnection	Document the amount of land used for the transmission interconnection and that no agricultural lands are disturbed	Contactor
Provision of Potable Water	Monitor water supply to ensure that it does not adversely affect other water uses in the area	Contactor
Handling and Storage of Fuels and Hazardous Materials	Document health and safety training.	Contactor
Storage of Fuels and Hazardous Materials	Spill Response Plan	Contactor
Aggregate Source	Records will be kept on quarries utilized	Contactor
Batch Plant – Concrete and Asphalt	Visible inspection of dust emissions should be performed daily with records of results	Contactor
Construction Work Force	A first aid station will be provided for workers onsite	Contactor
Delivery of Equipment and Materials	Visible inspection of dust from road construction should be ongoing and application of water should be employed to suppress dust during periods of high dust generation. Road speeds should be clearly posted.	Contactor
Solid Waste Disposal	Contact for proper disposal of solid waste should be kept onsite. Records on the date of disposal and the amount and type of solid waste disposed should be maintained	Contactor
Liquid Waste Disposal	Monitoring of the appropriate operational parameters should be performed as per the manufacturer's requirements	Contactor
Intake and Outfall Construction	Documentation on the siting study performed to locate the intake and discharge should be maintained onsite.	Contactor
Intake and Outfall Construction	Documentation on the siting study performed to locate the intake and discharge should be including a construction schedule and information on historic	Contactor

	fishing activity. A copy of this report should be maintained onsite	
Intake and Outfall Construction	Documentation of construction authorization should be maintained onsite	Contactor
Intake and Outfall Construction	The construction technique and means of minimizing sediment releases should be documented and a copy maintained onsite. Monitoring of mercury in sediments should be carried out if excavating and dredging are performed as part of the intake and outfall construction.	Contactor
Final Site	A plan for final grading and landscaping of the site should be developed and maintained onsite	Contactor

6.7 AIR QUALITY

The following parameters are to be monitored during the construction period:

- Hi-Vol dust
- Traffic dust

Hi-Vol dust sampling for a 24-hr period, once per month, throughout the construction period. The Hi-Vol samples will be used to monitor the impact of emissions from the batch plant. Dust from traffic movement will be spot-checked throughout the construction period to determine whether dust control measures are effective, or if further measures are required. Air quality will be monitored in confined spaces for worker safety when necessary.

Noise

Noise will be monitored once, at both day and night, for an eight-hour period at the perimeter of the site during the peak of construction activity. In addition, spot monitoring of various pieces of construction equipment will take place to ensure that noise emissions are not excessive. The site construction manager will maintain records of any noise complaints received during the construction process.

Terrestrial Environment

No specific monitoring of the terrestrial environment is proposed during the construction stage. It is assumed that site supervisors would be responsible for implementing best management practices and ensuring that disruption does not occur to site resources.

Site Drainage

In order to ensure that storm water discharge from construction site is effective, the drainage swales will be inspected on a monthly basis.

Marine Environment

No specific program is proposed to monitor construction activities in the marine environment. However, there should be on-going environmental inspections. Impacts related to the construction of the intake and discharge points, and work on the oil offloading terminal and SPM anchor will be local, and of short duration. Adherence to Best Management Practices, in terms of marine construction and disposal of waste materials, by the contractor involved in these activities should be stipulated in contract tender documents. Offshore disposal of excavated dredged material, if needed, will be as directed by the Albanian Ministry of the Environment. If monitoring of suspended solids is stipulated as part of their approval, it will be undertaken.

Operations

Each of the parameters identified in the operation mitigation plan will be monitored during construction. Table 8.4 identifies the monitoring parameters and responsibilities during operation of the facility. More specific information is given for various monitoring later in this section.

6.8 MONITORING PLAN FOR OPERATION

Activity	Monitored Parameters	Responsibility
Distillate Fuel Oil Combustion	Fuel Sulfur content will be monitored to ensure that it is less than or equal to 0.1% by weight. Sampling and analysis should be performed on each delivery received. An initial performance test should be performed to confirm the emissions from the plant do not exceed the amounts listed in this report. The stack should include continuous monitoring of NOx and opacity emissions.	Contactor
Equipment Operation	Baseline noise monitoring should be conducted prior to operation of the plant, both at the plant and at predefined receptor locations. Then, offsite, far field noise monitoring should be performed at those locations once during operation of the facility to confirm that the operation conforms to 70 dB(A) limit. Workers inclose proximity to the turbines or other noise emitting equipment should wear hearing protection in accordance with a written health and safety plan. A copy of the health and safety plan should be maintained onsite.	
Cooling Water Intake	Documentation should be maintained onsite concerning the final design of the water intake including the inlet	

	velocity	
Cooling Water Discharge	The condenser discharge temperature should be monitored to ensure the operation of the facility meets the maximum temperature discharge described in this report. Quarterly monitoring of the temperature at the discharge should be performed to confirm the maximum discharge temperature used in this analysis. In addition, pH and residual chlorine levels should be monitored on a continuous basis. Suspended solids and oil and grease should be measures semiannually.	
Fresh Water Supply	The use of water from the desalinization plant should be confirmed through maintaining the pertinent plant design documents onsite	
Sewage Treatment	Monitoring of the appropriate operational parameters should be performed as per the manufacturer's requirements	
Local Community Services	Maintain record on complaints concerning stress on the local community services created by the plant operation	
Handling and Storage of Fuels and Hazardous Materials	Maintain records to demonstrate adherence to the spill response plan.	
Handling and Storage of Fuels and Hazardous Materials	Maintain records to demonstrate adherence to the spill response plan.	
Handling and Storage of Fuels and Hazardous Materials	Maintain the pertinent design information onsite. Records on the date of discharge approximate of discharge, and final disposition of the discharge. Oil water separators should be equipped with an oil level indicator and inspected regularly	
Transmission of Power	The EMF emitted by the interconnection line should be monitored once at four locations along the line	
Aesthetics	The property maintenance records should be maintained onsite.	

Air

The air quality-monitoring program developed to assess ambient air quality conditions will be implemented following operation of the plant. The program consists of continuous monitoring of meteorological parameters including wind speed, wind direction, and ambient temperature and ambient pollutant concentrations of SO_2, NOx, and PM_{10}. The results of the monitoring should be used to assess the air quality relative to the air quality standards. Since local, site-specific meteorological and background pollutant concentration data was not available at the time this IEE was prepared, data from a site that exhibits similar characteristics was used in the analysis. While we do not anticipate the results of the air quality analysis in the current IEE to significantly change, we recommend that the project owner gather site-specific meteorological and air quality data for a period of one year in order to perform a more detailed air modeling analysis in the future to determine the exact impact of the plant on local conditions.

In addition, the flue gas characteristics of each generation unit will be determined after commencement of operation to ensure that emission performance criteria are met. Records to support analysis of this information (hours and times operational, fuel use, fuel characteristics, etc.) will also be maintained at the plant.

Noise

A noise-monitoring program will be undertaken during the operations phase to ensure compliance with noise emission specifications and predicted noise level impacts. One of the daytime monitoring periods will be scheduled to coincide with a high noise event so as to record the impact of that event at a downwind location on the site perimeter.

6.9 PHYSICAL AND BIOLOGICAL PARAMETERS

Physical Parameters

The condenser discharge temperature should be monitored continuously to ensure that the cooling water discharge temperature is in compliance with design criteria.. Site wastewater discharges, including runoff and discharge from the packaged sewage treatment plant should be monitored four times a year to verify compliance with design criteria.

6.10 CAPACITY DEVELOPMENT AND TRAINING

Formal training programs in all aspects of the plant operation should be developed and implemented for the plant staff. The programs are to commence prior to plant start-up and will be conducted for new employees. The training programs will be designed to enable staff to become fully competent in the operation and maintenance of the generating facility. As this will be the first combined cycle facility in Albania, the staff will have limited work experience in operating and maintaining this type of facility and the training programs should reflect this. This training is to be provided in country and be of two weeks duration.

Environmental training will be incorporated into these overall training programs. It is important that all plant employees are aware of environmental requirements and that proper operation of the plant reduces negative environmental impacts. It is to be impressed that sound environmental management is in everyone's best interest besides conforming to lending and permitting requirements.

A detailed environmental management and training program must be developed. The major components of this program must incorporate the following:

- General information
- General understanding of the concept of sustainability and reasons for sound environmental management

Understanding of potential environmental impacts that can be expected from the two main phases of the power plant development

Construction &Operation

- Reasons for proposed mitigation measures
- Establishing chain of responsibility and decision-making
- Specific training
- Air and water quality monitoring
- Criteria for establishment of monitoring stations
- Methodology to be used for field sampling
- Training in the use of field equipment and correct techniques for sample preservation
- Training in required laboratory analyses and the importance of quality assurance and quality control methods
- Training In identification of noncompliance situations and procedures to be followed in such instances
- Reporting requirements
- Training for inspectors/supervisors during construction, emphasizing the major environmental areas where their effort should be concentrated
- Handling, transporting, and disposal of hazardous materials, including used oil
- Procedures for off loading oil, specifically to eliminate spillage during plant operation
- Health and safety requirements
- Noise monitoring
- Emergency and spill response, especially for oil at sea and on site
- Good housekeeping

6.11 ENVIRONMENTAL AND HEALTH AND SAFETY PROCEDURES

Environmental and health and safety procedures are to be developed for both the construction and operation phase of the project. These procedures will provide management with the necessary guidelines for both environmental protection and the protection of the workers' health and safety. MEL should prepare the plans and base them on any existing health and safety procedures that they have. Existing procedures should be expanded as appropriate for the plant.

Besides detailed procedures, a simplified handbook should be developed for all employees outlining the importance of environmental and health and safety practices. A tentative list of procedures is provided below:

- Health and safety procedures
- Administration and organization
- Project emergency practices
- Tunnel rescue
- Work over or near water
- First aid and medical services
- Control measures
- Safety officer
- Site security
- Safety tagging and lock out
- Training and orientation
- Accident investigation, reporting and record keeping
- Workplace hazardous material information system (WHMIS)
- Specific safety requirements
- Confined space entry
- Employer safety programs
- Project health and safety committees
- Use of personal protective equipment
- Personal decontamination practices.
- Environmental Procedures
- Noise and vibration plan
- Contacting outside agencies
- Handling, storage, and disposal of fuels and hazardous materials
- Site aesthetics and restoration
- Site drainage, dewatering, erosion and sediment control
- Waste management plan
- Dust control

- Spill response plan
- Water monitoring
- Air monitoring
- Community relations
- Environmental inspection
- Oil handling plan.

EMP/Project Integration

To ensure that the provisions of the EMP are fully integrated into the project, contracts and other means will be used with the appropriate organizations. The elements of the EMP that deal with activities during construction will be the responsibility of the construction contractor. These items include the following:

- Impact mitigation during construction
- Study to support location of intake and discharge structures
- Oil spill response/recovery mitigation plan
- Social impacts from influx of workers
- Monitoring during construction
- Health and safety training
- Capacity development and training

MEL will be responsible for operation of the plant and will bear the responsibility for implementing the operational elements of the EMP. The heart of this responsibility will be for development of the detailed environmental management and training program. This program is a comprehensive means of building the awareness and capacity for plant personnel to implement the mitigation and monitoring elements of the EMP.

6.12 ENVIRONMENTAL MANAGEMENT CELL

An environment management cell shall be created which shall perform the following functions:

- Achieve objectives of the 'Environment Protection Policy' of the management.
- Collect information from regular monitoring and create a database
- Analyze the data and decide thrust area.
- Based on the data collected, decide target for each thrust area.
- Carry out 'Projects' in each thrust area to arrive at practical solutions to environmental problems.
- Discuss the reports of study on environment and disseminate the information.
- Work out 'Action plan' for implementation of the recommendations made in the reports
- .Prepare Management Information System (MIS) reports and budget for environment management program.

- The Plant Manager will be responsible for environmental issues at plant.

The responsibilities of the various members of the environment management cell are given in Table 7.2 Diagram of Environment Management Cell is given in Fig.7.1

Table 6.4: Environmental Management Cell

Sr. No	Designation	Proposed responsibility
1.	Resident Director	Environmental policy maker and decision maker
2.	General Manager (Operations)	Overall responsibility for environmental management and decision making for all environmental issue
3.	Plant Manager	Overall in-charge of operation of environmental management facilities. Ensuring legal compliance by properly undertaking activities as laid down by various regulatory agencies from time to time and interacting with the same.
4.	EHS in-charge	Overall in-charge of operation of environmental management facilities. Ensuring legal compliance by properly undertaking activities as laid down by various regulatory agencies from time to time and interacting with the same. Arranging awareness programme among the workers

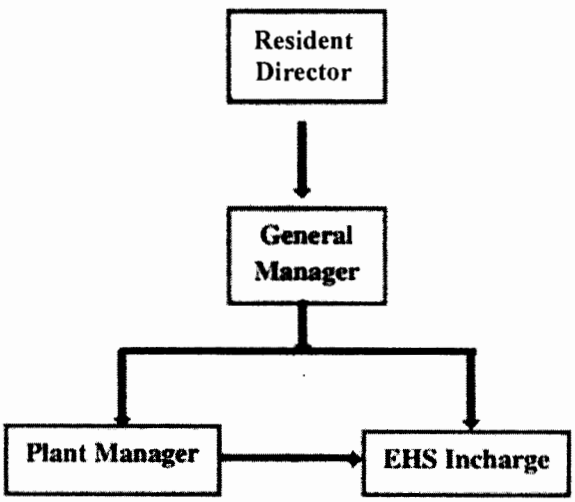
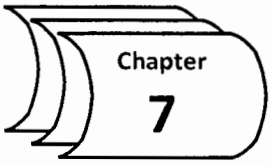


Fig 6.1: Organo-gram



CONCLUSION

7.1 CONCLUSION

The analysis performed to fulfill the EIA/IEE requirement follows international standards. The EIA establishes the baseline condition of the site and assesses the impact of the proposed generation facility on area resources. The likely positive and negative impacts of the proposed project are identified and quantified to the extent possible. Mitigation measures to be taken during construction and operation of the facility and any residual negative impacts are identified.

- The planned generation facility is a state of the art combined cycle unit and will meet all applicable international standards for air emissions.
- An Electrostatic Precipitator (ESP) will be used to collect the fly ash and together with the bottom ash from the boiler, the bagasse ash will be used as manure / fertilizer on corporate farms and also made available to growers in the region.
- The Effluent generated from Co- generation power plant will be neutralized and will be treated into the existing sugar ETP. The treated water from the sugar ETP will be used for agriculture purpose and for sprinkling inside the plant boundary wall and left over if any, discharged into the nearby farms of Mehran Energy Limited.

In summary, the planned facility meets all international environmental standards and will have a positive impact on the local economy without stressing the local infrastructure and services. In addition, the facility will alleviate many of the severe problems currently being experienced in the Albanian electric power system

ANNEXURE-I

WILDLIFE PROTECTED AREAS

Protected Area Name	Area (ha)	Classification	Coordinates
Bijoro Chach	121	Wildlife Sanctuary	Not Recorded
Cut Munarki Chach	405	Wildlife Sanctuary	Not Recorded
Deh Akro/Nara Canal	20,000	Wildlife Sanctuary	27/42 N. 68/52 E
Deh Jangisar	314	Game Reserve	Not Recorded
Deh Khalifa	429	Game Reserve	Not Recorded
Deh Sahib Saman	349	Wildlife Sanctuary	Not Recorded
Dhoung Block	2,098	Wildlife Sanctuary	Not Recorded
Dograyon Lake	648	Wildlife Sanctuary	Not Recorded
Dosu Forest	2312	Game Reserve	Not Recorded
Drigh Lake	164	Wildlife Sanctuary	Not Recorded
Ghamo	27283	Game Reserve	Not Recorded
Ghondak Dhoro	31	Wildlife Sanctuary	Not Recorded
Gullel Khon	40	Wildlife Sanctuary	Not Recorded
Gulsher Dhand	24	Wildlife Sanctuary	Not Recorded
Hadero Lake	1321	Wildlife Sanctuary	24/50 N. 67/53 E
Hala	954	Game Reserve	25/48 N. 68/25 E.
Haleji Lake	1704	Wildlife Sanctuary	24/49 N. 67/44 E.
Hilaya	324	Wildlife Sanctuary	Not Recorded
Indus River	44200	Game Reserve	28/24 N. 69/45 E
Keti Bunder South	8948	Wildlife Sanctuary	24/08 N. 67/27 E.
Keti Bunder North	23040	Wildlife Sanctuary	24/08 N. 67/27 E
Khadi 81	81	Wildlife Sanctuary	Not Recorded
Khairpur Game Reserve	Not Recorded	Unclassified	Not Recorded
Khanpur	Not Recorded	Unclassified	Not Recorded
Khat Dhoro	11	Wildlife Sanctuary	Not Recorded
Khipro	3885	Game Reserve	25/49 N. 69/21E
Kinjhar (Kain) Lake	13468	Wildlife Sanctuary	29/54 N. 70/57 E.
Kirthar	308733	National Park	25/44 - 27/15 N 67/10.E
Kot Dinghano	30	Wildlife Sanctuary	Not Recorded
Lakht	101	Wildlife Sanctuary	26/36 N. 67/53 E.
Langh (Lungh) Lake	19	Wildlife Sanctuary	27/30 N. 68/03 E.
Mahal Kohistan	70577	Wildlife Sanctuary	Not Recorded
Mejiran	24	Wildlife Sanctuary	Not Recorded
Mando Dero	1234	Game Reserve	Not Recorded
Marho Kohn	162	Wildlife Sanctuary	Not Recorded
Miani Dhand	57	Game Reserve	25/27 N. 68/23 E

Mirpur Sakro	777	Wildlife Sanctuary	24/32 N. 67/38 E
Mubahat Dero	16	Wildlife Sanctuary	Not Recorded
Munarki	12	Wildlife Sanctuary	Not Recorded
Nara	109966	Game Reserve	27/42 N. 68/52 E
Nara Desert	223590	Wildlife Sanctuary	Not Recorded
Norang	243	Wildlife Sanctuary	Not Recorded
Pai	1069	Game Reserve	Not Recorded
Pir Mahfooz Game Reserve	Not Recorded	Unclassified	Not Recorded
Pir Pagara Game Reserve	Not Recorded	Unclassified	Not Recorded
Sadnani	320463	Wildlife Sanctuary	Not Recorded
Samno Dhand	84	Wildlife Sanctuary	Not Recorded
Samno Dhand	23	Wildlife Sanctuary	Not Recorded
Shah Lanko	61	Wildlife Sanctuary	Not Recorded
Surjan, Sumbak, Eri and Hothiano	40632	Game Reserve	25/25 N. 67/55 E.
Surjan, Sumbak, Eri and Hothiano	43513	Wildlife Sanctuary	27/15 N. 68/49 E.
Tando Matha Khan	5343	Game Reserve	Not Recorded

ANNEXURE-II

RELEVANT HEALTH, SAFETY ENVIRONMENTAL LAWS AND THEIR APPLICABILITY

Subject	Legislative Power	Enforcing Agencies	Pertinent Laws
Environmental Pollution and Ecology	Federal and Provincial	Ministry of Environment Local Government and Rural Development	Pakistan Environmental Protection Act, 1997
		Pakistan Environmental Protection Agency	National Environmental Quality (NEQS), 2000
		Sindh Environmental Protection Agency	NEQS (Self-Monitoring and Reporting by Industry) Rules, 2001
Boilers	Federal & Provincial	The Boiler Board Chief Inspector of Boilers	NEQS (Self-Monitoring and Reporting by Industry). Rules, 2001
Regulation of Labor and Safety in factories	Federal and Provincial	Chief Inspector of Industries	Factories Act, 1934
			Hazardous Occupation Rules, 1963
Electricity	Federal and Provincial	Federal Electricity Boards	Electricity Act, 1910
Ancient and historical monuments; archaeological sites and remains	Federal and Provincial	Departments of Museum	Antiquities Act, 1975, Sindh Cultural Heritage Act, 1994

ANNEXURE-III

POTENTIAL NEGATIVE IMPACTS VS MITIGATION MEASURES SITE SELECTION

Potential Negative Impacts Site Selection	Specific Mitigation Measures Site Selection
1. Plant sure near sensitive habitats, eg: • estuaries • mangroves	• Locate facility elsewhere, eg. Within industrial estate which are equipped to deal with stress on local environment services. It should also facilitate the monitoring of emissions. This will concentrate and from sensitive air quality receptors
2. Water course degradation	• Examine alternate site location that will not affect beneficial use of water course. • Check water course capacity to assimilate treated effluent • Dilute effluent at point of discharge
3. Air pollution problems for locals	• Locate plant site based an assessment of pollution trapping and prevailing winds are towards relatively unpopulated areas.
4. Solid waste problems	• Select site with landfill disposal on-site, or • Proximity to suitable disposal site with easy system for solid waste collection for final disposal

ANNEXURE-IV

POTENTIAL NEGATIVE IMPACTS VS MITIGATION MEASURES PLANT OPERATION

Potential Negative Impacts Plant Operation	Specific Mitigation Measures Plant Operation
1. Water contamination with high temperature, BOD, COD, TDS, and pH due to • Process cooling waster • Effluents, or • Runoff from stockpiles / waste piles	• Recycling cooling water. If this is not feasible ensure receiving body waster temperature does not rise > 3°C • Maintain pH between 6-9 • Control effluent to specified NEQS • Minimize rain exposure to stockpiles and minimize uncontrolled runoff • Line open storage areas to collect all storm water.
2. Particulate emissions	• Use Fabric (Baghouse) Filter or Electrostatic Precipitators.
3.Gaseous emissions, eg: o SO_{x1} NO_{X1} CO and others.	• Scrub with water or alkaline solutions • Incinerate, or • Absorption by other catalytic process.
4. Accidental release of hazardous solvent	• Assess use of double wall tanks • Housekeeping and maintenance to prevent accident • Provide and maintain spill kits.
5. Noise	• Use low rated equipment • Control timing of noise and vibration to least disruptive periods • Install noise barriers
6. Groundwater contamination	• Cover and contain open storage areas to prevent runoff to surface and ground waters • Use lines disposal cells to prevent ground water seepage • Monitor storm water quality before discharge

25.	Total toxic metals	2.0
26.	Zinc	5.0
27.	Arsenic*	1.0
28.	Barium*	1.5
29.	Iron	8.0
30.	Manganese	1.5
31.	Boron*	6.0
32.	Chlorine	1.0

Explanations

- The effluent should not result in a temperature increase of more than 3 °C at the edge of the zone where initial mixing and dilution take place in the receiving body. In case zone is not defined, use 100 meters from the discharge point;
- Assuming minimum dilution 1:10 on discharge; lower ratio would attract progressively stringent standards to be determined by the Sindh Environmental Protection Agency (SEPA);
- 1:10 dilution means that for each one cubic meter of treated effluent the recipient water body should have 10 cubic meters of water for the dilution of this effluent;
- Modified Benzene Alkyl Sulfate; assuming surfactant as biodegradable;
- Pesticides include herbicides, fungicides, and insecticides;
- Subject to total toxic metal discharge should not exceed level given at Sr. No. 25.

Notes:

1. Dilution of liquid effluents by mixing them with fresh water to bring them to the SEQS limiting values before discharging to the environment is not permissible.

2. The concentration of pollutants in water being used will be subtracted from the effluent for calculating the SEQS limits.

ANNEXURE-VII

SINDH ENVIRONMENTAL QUALITY STANDARDS FOR SELECTED GASEOUS POLLUTANTS FROM INDUSTRIAL SOURCES

No	Parameter	Sources of Emissions	Standards
1	Smoke	Smoke opacity not to exceed	40% or 2 on Rnglemann
2	Particulate matter	Boilers and furnaces:	
		Oil fired	300mg / Nm3
		Coal fired	500mg / Nm3
		Cement Kilns	300mg / Nm3
		Grinding, crushing, clinker, coolers and related process, converter, blast furnaces and cupolas	500mg / Nm3
3	Hydrogen Chloride	Any	400mg / Nm3
4	Chlorine	Any	150mg / Nm3
5	Hydrogen Fluoride	Any	150 mg / Nm3
6	Hydrogen Sulfide	Any	10 mg / Nm3
7	Sulfur Oxides	Sulfuric Acid / Sulfonic acid plants	5,000 mg / Nm3
8	Carbon dioxide	Any	800 mg / Nm3
9	Lead	Any	50 mg / Nm3
10	Mercury	Any	10 mg / Nm3
11	Cadmium	Any	20 mg / Nm3
12	Arsenic	Any	20 mg / Nm3
13	Copper	Any	50 mg / Nm3
14	Antimony	Any	20 mg / Nm3
15	Zinc	Any	200 mg / Nm3
16	Oxides of Nitrogen[4]	Other plants except power plants operating on oil or gas:	
		Cement kilns	1,200 mg / Nm3
		Oil fired	400 mg / Nm3

Coal fired	600 mg / Nm3

Notes:

- All values are in mg / Nm3, unless otherwise defined
- Based on the assumption that the size of the particulate is 10 microns or more.
- Based on 1% sulfur content in fuel oil. Higher content of sulfur will cause standards to be pro-rated
- In respect of emission sulfur dioxide and nitrogen dioxide. The power plants operation on oil and coal as fuel shall comply with the National Environmental Quality Standards.

ANNEXURE-VIII

SINDH ENVIRONMENTAL QUALITY STANDARDS FOR NOISE

Sindh Environmental Quality Standard for Noise

S. No.	**Category of Area / Zone**	**Effective from 1st January, 2009**		**Effective from 1st January, 2010**	
		Limit it in dB(A) Leq*			
		Day Time	**Night Time**	**Day Time**	Night Time
1	Residential area (A)	65	50	55	45
2	Commercial area (B)	70	60	65	55
3	Industrial area (C)	80	75	75	65
4	Silence Zone (D)	55	45	50	45

Note: 1 Day time hours: 6.00 a. m to 10.00 p. m

2 Night time hours: 10.00 p. m to 6.00p. m

3 Silence zone; Zone which are declared as such by competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.

4 Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.

*dB(A)Leq Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

Report No. PPI-229.3-Final/17

INTERCONNECTION STUDY

For

26.5 MW Mehran Energy Limited PP, Deh Daro Sutha Tando Adam Road, District Tando Allahyar, Sindh

Final Report
(March 2017)

POWER PLANNERS INTERNATIONAL

UK Office:
3-Sylvester Road,
Sudbury Town, Middlesex,
HA0 3AQ, UK
Phone & Fax:+44-(0)208-9223219

Pakistan Office:
64-F/1, Wapda Town,
Lahore, Pakistan
Phone: +92-42-35182834-35;
Fax: + 92-42-35183166

Email: info@powerplannersint.com
www.powerplannersint.com

Executive Summary

- The Final Report for interconnection of 26.5 MW Bagasse Cogeneration Power Plant by Mehran Energy Limited with HESCO grid system is submitted herewith.
- Mehran Energy Limited would like to go for high pressure cogeneration with the aim of exporting maximum 23.75 MW power to the national grid.
- The study objective, approach and methodology have been described and the plant's data received from the Client is validated. The network around Mehran Energy Limited PP (referred to as Mehran Energy PP/ MEL PP in the remainder of the report) at 132 kV and 11 kV has been modeled as shown in Appendix-B (Sketch-1).
- The nearest HESCO grid facility available for interconnection to Mehran Energy PP is existing 132 kV circuit between Mirpurkhas 132 kV Grid Station and Usman Shah 132 kV Grid Station.
- Keeping in view the location of Power Project, the most feasible interconnection scheme would be looping in-out the existing 132 kV circuit between Mirpurkhas to Usman Shah at Mehran-PP. The looping distance as confirmed from site visit would be 1 km and the conductor used would be Lynx. The scheme is shown in Sketch-2 in Appendix-B.
- Mehran Energy PP would generate power at 11 kV voltage level from where it is stepped-up to 132 kV using two 132/11 kV transformers with rating of 31.5/40 MVA.
- The proposed scheme would require two 132 kV line bays at the 132 kV substation of Mehran Energy PP for the connection of 132kV circuit to both Mirpurkhas and Usman Shah Grid stations. Furthermore it would also require two transformer bays for the connection of two 132/11 kV transformers with rating of 31.5/40 MVA.
- With the gross capacity of 26.5 MW, the spillover from Mehran Energy PP would be 23.75 MW in Off-Season and 21.11 MW in the Crushing Season.
- In view of planned COD of the Mehran Energy PP in November 2018, the above proposed interconnection scheme has been tested for steady state conditions through detailed load flow studies for the peak conditions of

- January 2019 for maximum thermal power dispatches in the grid during the Crushing Season for Mehran Energy PP.
- September 2019 for maximum hydropower dispatches in the grid during the off-season of Mehran Energy PP.

The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.

- The proposed scheme of interconnection has also been tested for the extended term scenario of peak load conditions of the year 2021 for steady state conditions.
- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the spillover of up to 23.75 MW power of the Plant under normal as well as contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at Mehran Energy PP and the substations of 132 kV in its vicinity. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear installed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from Mehran Energy PP.
- The maximum short circuit levels of Mehran Energy PP 132 kV is 6.96 kA and 6.83 kA for 3-phase and 1-phase faults respectively for the Year 2019 and 7.09 kA and 6.94 kA for 3-phase and 1-phase faults respectively for the Year 2021. It would be advisable to go for standard size switchgear of short circuit rating of 40 kA. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.
- The dynamic stability analysis of proposed scheme of interconnection has been carried out for January 2019. The stability check for the worst case of three phase fault right on the 132 kV bus bar of Mehran Energy PP substation followed by the final trip of one 132 kV circuit emanating from this substation, has been performed for fault clearing of 5 (100 ms) and 9 cycles (180 ms), in case of stuck breaker, as understood to be the normal fault clearing time of 132 kV protection system. The stability of system for far end faults of 3-phase occurring at 132 kV bus bar have also been checked. The proposed scheme successfully passed the

dynamic stability checks for near and far faults for the most stringent cases. The system is found strong enough to stay stable and recovered with fast damping.

- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

Report Contents

1. Introduction

1.1 Background

Mehran Energy Limited would like to go for high pressure cogeneration with the aim of exporting spillover power to the National Grid. The electricity generated from this project would be supplied to the grid system of HESCO through 132 kV grids available in the vicinity of this project. The nearest grid facility is the single circuit between Mirpurkhas 132 kV Grid Station and Usman Shah 132 kV Grid Station as shown in Sketch-1 in Appendix-B.

1.2 Objectives

The overall objective of the Study is to evolve an interconnection scheme between Mehran Energy PP and HESCO network, for stable and reliable evacuation of the electrical power generated from this plant, fulfilling N-1 reliability criteria. The specific objectives of this report are:

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

1.3 Planning Criteria

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

Steady State:

Voltage	± 5 %, Normal Operating Condition
	± 10 %, Contingency Conditions
Frequency	50 Hz Nominal
	49.8 Hz to 50.2 Hz variation in steady state
	49.4 - 50.5Hz, Min/Max Contingency Freq. Band

Short Circuit:

Substation Equipment Rating for 132 kV should be 31.5 kA or 40 kA.

Dynamic/Transient:

The system should revert back to normal condition after dying out of transients without loosing synchronism with good damping after permanent three-phase fault on any primary transmission element; including: transmission circuit, substation bus section, transformer, or circuit breaker. It is assumed that such a fault shall be cleared by the associated circuit breaker action in 5 cycles.

In case of failure of primary protection (stuck breaker case), the total fault clearing time from the instant of initiation of fault current to the complete interruption of current to isolate the faulted element, including the primary protection plus the backup protection to operate and isolate the fault, is equal to 180 ms (9 cycles) for 132 kV and higher voltage levels.

2. Technical Data

The number of generating units at Mehran Energy PP is one. The following data have been provided by the Client:

2.1 Mehran Energy PP data

Generator data:

Gross capacity of power plant	= 1x26.5 = 26.5 MW
Lump sum MVA capacity	= 1x33.125 = 33.125 MVA
Generating Voltage	= 11 kV
Power factor	= 0.80 lagging

Crushing Season:

Load + Auxiliary Consumption	= 5.39 MW
Spillover to the Grid	= 21.11 MW

Off-Season:

Load + Auxiliary Consumption	= 2.75 MW
Spillover to the Grid	= 23.75 MW

GSU Transformer	= 31.5/40 MVA (x2)
GSU Transformer reactance	= 12.5 %

2.2 Network data

The latest Generation Expansion Plan and Load Forecast has been used as provided by NTDC and is shown in Appendix-A.

The 132 kV network in the area near Mehran Energy PP are as shown in Sketches in Appendix-B. The system data of HESCO has been used as already available with PPI.

3. Study Approach and Methodology

3.1 Understanding of the Problem

Mehran Energy Limited would like to go for high pressure cogeneration with the aim of exporting a maximum of 23.75 MW supply to the grid during the Off-Season and 21.11 MW in Crushing Season. The proposed Power Project is going to be embedded in the transmission network of HESCO through this nearest available 132 kV network.

The adequacy of HESCO network of 132 kV in and around the proposed site of Mehran Energy PP has been investigated in this study for absorbing and transmitting this power fulfilling the reliability criteria.

3.2 Approach to the problem

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for January 2019 (Crushing Season) and September 2019 (Off-Season) after the commissioning of Mehran Energy PP in November 2018, comprising all 500 kV, 220 kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year particularly in HESCO.
- Month of January 2019 and September 2019, while representing Crushing Season and Off-Season respectively, also represent low water and high water conditions respectively in the grid system. Thus both the high water and low water flow patterns can be observed allowing us to judge the maximum impact of the plant on the transmission system in its vicinity. In addition, case for extended term scenario of the year 2021 has also been studied.
- Interconnection scheme without any physical constraints, like right of way or availability of space in the terminal substations, have been identified.
- Perform technical system studies for peak load conditions to confirm technical feasibility of the interconnections. The scheme will be subjected to standard analysis like load flow, short circuit, and transient stability study to check the strength of the machines and the proposed interconnection scheme under disturbed conditions.

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

4. Development of Scheme of Interconnection

4.1 The Existing and Ongoing Network

Mehran Energy Limited is located near Deh Daro Sutha, District Tando Allahyar embedded in the distribution network of HESCO. The existing 132 kV network available around Mehran Energy PP is shown in Sketch-1 in Appendix-B.

The system around Mehran Energy PP has another co-generation power plant in the vicinity i.e. Faran Sugar Mills PP. There is a strong 220 kV network in the vicinity connecting Hala Road 220/132 kV grid station with Jamshoro 220 kV, T.M.Khan 220 kV and Mirpur Khas 220 kV substations. A strong system helps in stable operation of a power plant.

4.2 The Scheme of Interconnection of Mehran Energy PP

Keeping in view of the above mentioned 132 kV network available in the vicinity of the site of the Mehran Energy PP, the interconnection scheme for Mehran Energy PP has been developed. According to the new scheme, it is proposed to connect Mehran Energy PP via loop in-out the existing 132 kV single circuit between Mirpurkhas and Usman Shah Grid stations. The looping distance as confirmed from site visit would be 1 km and the conductor used would be Lynx. The scheme is shown in Sketch-2 in Appendix-B. The network around Mehran Energy PP has been modeled at 132 kV and 11 kV.

5. Detailed Load Flow Studies

5.1 Peak Case Load Flow January 2019, without Mehran Energy PP

A base case has been developed for the peak load of January 2019 using the network data of NTDC and HESCO available with PPI, after updating with latest load forecast and expansion plan of NTDC and HESCO. The peak load of the year 2018-19 for HESCO has been modeled as per the latest PMS Demand forecast obtained from NTDC.

The results of load flow for this base case are plotted in Exhibit 0.0 of Appendix-C. The system plotted in this Exhibit comprises of 132 kV network feeding Hala Road, Tando Jam, Tando Allah Yar, Chamber, Mirpur Khas and the surrounding areas.

The load flow results show that the power flows on all the circuits are within their normal rating. The voltage profile of these surrounding substations is also within normal limits.

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

Exhibit 0.1	Trip Usman Shah H to Mirpurkhas 132 kV Single Circuit Out
Exhibit 0.2	Trip Hala Road to Usman Shah H 132 kV Single Circuit Out
Exhibit 0.3	Trip Mirpurkhas to T.A.Yar 132 kV Single Circuit Out
Exhibit 0.4	Trip Mirpurkhas to Mirpurkhas-2 132 kV Single Circuit Out
Exhibit 0.5	Trip Mirpurkhas to Mir Wahg 132 kV Single Circuit Out

We see that in all the cases the power flows on all circuits remain within their rated limit. Also the bus voltages are within the acceptable operating range.

5.2 Peak Case Load Flow January 2019, with Mehran Energy PP in Crushing Season

The scheme of interconnection modeled in the load flow for Mehran Energy PP is as described in Chapter-4.

Load flow studies have been carried out for January 2019 because it represents the maximum thermal power dispatch conditions in the grid during the Crushing Season condition of Mehran Energy PP. Thus the loading on the lines in the vicinity of Mehran Energy PP will be maximum, allowing us to judge the maximum impact of the plant on the transmission system in its vicinity. The results of load flow with Mehran Energy PP interconnected as per proposed scheme are shown in Appendix-C.

The results of Normal case of Peak January 2019 are plotted in Exhibit 1.0. We find no capacity constraints on 132 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 1.1	Trip MEL-PP 132/11 kV Single Transformer Out
Exhibit 1.2	Trip MEL-PP to Mirpurkhas 132 kV Single Circuit Out
Exhibit 1.3	Trip Usman Shah H to MEL-PP 132 kV Single Circuit Out
Exhibit 1.4	Trip Hala Road to Usman Shah H 132 kV Single Circuit Out
Exhibit 1.5	Trip Mirpurkhas to T.A.Yar 132 kV Single Circuit Out
Exhibit 1.6	Trip Mirpurkhas to Mirpurkhas-2 132 kV Single Circuit Out
Exhibit 1.7	Trip Mirpurkhas to Mir Wahg 132 kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the permissible limits in all the contingency events.

5.3 Peak Case Load Flow September 2019, with Mehran Energy PP in Off-Season

The scheme of interconnection modeled in the load flow for Mehran Energy PP is as described in Chapter-4.

Load flow studies have been carried out for September because it represents the maximum hydropower dispatch conditions in the grid during the Off-Season of Mehran Energy PP. The results of load flow with Mehran Energy PP interconnected as per proposed scheme are shown in Appendix-C.

The results of Normal case of Peak September 2019 are plotted in Exhibit 2.0. We find no capacity constraints on 132 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 2.1	Trip MEL-PP 132/11 kV Single Transformer Out
Exhibit 2.2	Trip MEL-PP to Mirpurkhas 132 kV Single Circuit Out
Exhibit 2.3	Trip Usman Shah H to MEL-PP 132 kV Single Circuit Out
Exhibit 2.4	Trip Hala Road to Usman Shah H 132 kV Single Circuit Out
Exhibit 2.5	Trip Mirpurkhas to T.A.Yar 132 kV Single Circuit Out
Exhibit 2.6	Trip Mirpurkhas to Mirpurkhas-2 132 kV Single Circuit Out
Exhibit 2.7	Trip Mirpurkhas to Mir Wahg 132 kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the permissible limits in all the contingency events.

5.4 Peak Load Case 2021: Extended Term Scenario

We have also studied the future scenario of Year 2021 to assess the impact of the plant in the extended term.

The results of Normal case of Peak 2021 are plotted in Exhibit 3.0. The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 5 % off the nominal.

We find no capacity constraints on 132 kV circuits under normal conditions i.e. without any outages of circuits.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 3.1	Trip MEL-PP 132/11 kV Single Transformer Out
Exhibit 3.2	Trip MEL-PP to Mirpurkhas 132 kV Single Circuit Out
Exhibit 3.3	Trip Usman Shah H to MEL-PP 132 kV Single Circuit Out
Exhibit 3.4	Trip Hala Road to Usman Shah H 132 kV Single Circuit Out
Exhibit 3.5	Trip Mirpurkhas to T.A.Yar 132 kV Single Circuit Out
Exhibit 3.6	Trip Mirpurkhas to Mirpurkhas-2 132 kV Single Circuit Out
Exhibit 3.7	Trip Mirpurkhas to Mir Wahg 132 kV Single Circuit Out

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 10 % off the nominal for contingency conditions' criteria

We find that there are no capacity constraints in the proposed connectivity scheme of Mehran Energy PP.

5.5 Analysis of Voltage Profile and Transmission Line Losses

a) Voltage Profile

The voltage profile on the buses near Mehran Energy Limited Power Plant was analyzed. The voltages on the bus bars in the vicinity of MEL PP have been shown in Table 5.1 for comparison. These voltages are also shown in Exhibit 0.0 (without MEL PP) and Exhibit 1.0 (with MEL PP).

Table – 5.1

Bus Bars	Voltage (kV)	
	Without MEL PP	With MEL PP
Usman Shah.H 132 kV	133.7	134.7
Mirpurkhas 132 kV	134.0	134.0

It can be seen that the overall voltage profile of the area improves after the introduction of MEL PP into the system.

b) Transmission Line Losses

The transmission line losses were evaluated for normal case of peak load January 2019 from Mehran Energy Limited PP to the point of interconnection (looping distance is 1 km). The PSS/E generated report of transmission line losses was used to calculate transmission line loss as a percentage of the flow.

% Power Loss from MEL PP towards Mirpurkhas = (0.0073)/26.0490
= 0.0002802 x 100 = **0.02802 %**

% Power Loss from MEL PP towards Usman Shah = (0.0009)/4.9390
= 0.000182 x 100 = **0.0182%**

It can be seen that the transmission loss of the transmission line from Power plant to the point of interconnections is less than 1%.

5.6 Conclusion of Load Flow Analysis

The proposed interconnection scheme of Mehran Energy PP is adequate to evacuate the spillover electrical power from Mehran Energy PP under normal and contingency conditions tested for peak load conditions of January 2019, September 2019 and extended term scenario of the Year 2021. In all the normal and contingency cases, we find that the loading on the circuits remain within the rated capacity. Also the bus bar voltages are well within the permissible limits in all the normal and contingency events. Hence the proposed interconnection scheme of Mehran Energy PP has no constraints according to the Load Flow Analysis.

6. Short Circuit Analysis

6.1 Methodology and Assumptions

The methodology of IEC 909 has been applied in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies.

The maximum fault currents have been calculated with the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition.

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2019 i.e. all the generating units have been assumed on-bar in fault calculation's simulations.

The assumptions about the generator and the transformers data are the same as mentioned in Ch.2 of this report.

6.2 Fault Current Calculations without Mehran Energy PP – Year 2019

In order to assess the short circuit strength of the network of 132 kV without Mehran Energy PP for the grid of HESCO in the vicinity of the site of the Plant, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. These levels will give us the idea of the fault levels without Mehran Energy PP and later on how much the contribution of fault current from Mehran Energy PP may add to the existing levels.

The results are attached in Appendix – D.

The short circuit levels have been calculated and plotted on the bus bars of 132 kV of substations lying in the electrical vicinity of our area of interest i.e. Hala Road, Tando Jam, Tando Allah Yar, Chamber, Mirpur Khas and surrounding bus bars and are

shown plotted in the Exhibit 4.0 attached in Appendix-D. Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-D for the 132 kV bus bars of our interest. The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 6.1. We see that the maximum fault currents do not exceed the short circuit ratings of the equipment at these 132 kV substations which normally are 25 kA or 31.5 kA for older substations and 40 kA for new substations.

Table-6.1
Maximum Short Circuit Levels without Mehran Energy PP - Year 2019

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Chamber 132 kV	6.12	5.89
Shaikh Bhirkio 132 kV	4.54	4.59
Tandojam 132 kV	10.75	10.04
T. A. Yar 132 kV	9.68	9.50
Sultanabad 132 kV	11.65	11.31
Mirpurkhas 132 kV	13.97	15.12
Mirpurkhas-2 132 kV	9.76	10.08
MirpurKhas –PP 132 kV	8.91	9.13
Mir Wah Gurchani 132 kV	6.50	5.91
Kot GM 132 kV	5.39	5.15
Usman Shah Huri 132 kV	5.97	4.86
FPL PP 132 kV	4.64	4.93
Samaro 132 kV	6.11	6.41
Hala Road 132 kV	22.74	23.23
Hala Road-1 132 kV	16.25	16.55

6.3 Fault Current Calculations with Mehran Energy PP – Year 2019

Fault currents have been calculated for the electrical interconnection of proposed scheme. Fault types applied are three phase and single-phase at 132 kV bus bars of Mehran Energy PP itself and other bus bars of the 132 kV substations in the electrical vicinity of Hala Road, Tando Jam, Tando Allah Yar, Chamber and Mirpur Khas. The graphic results showing maximum 3-phase and 1-phase fault levels are indicated in Exhibit 4.1. Both 3-phase and 1-phase fault currents are indicated in the Exhibit

which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV bus bars of the network in the electrical vicinity of Mehran Energy PP are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.2

Table-6.2
Maximum Short Circuit Levels with Mehran Energy PP – Year 2019

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
MEL PP 132 kV	6.96	6.83
Chamber 132 kV	6.15	5.91
Shaikh Bhirkio 132 kV	4.55	4.60
Tandojam 132 kV	10.81	10.08
T. A. Yar 132 kV	9.78	9.57
Sultanabad 132 kV	11.89	11.51
Mirpurkhas 132 kV	14.34	15.53
Mirpurkhas-2 132 kV	9.92	10.22
MirpurKhas-PP 132 kV	9.04	9.22
Mir Wah Gurchani 132 kV	6.57	5.96
Kot GM 132 kV	5.45	5.17
Usman Shah Huri 132 kV	6.29	5.66
FPL PP 132 kV	4.66	4.94
Samaro 132 kV	6.16	6.44
Hala Road 132 kV	22.92	23.39
Hala Road-1 132 kV	16.33	16.60

Comparison of Tables 6.1 and 6.2 show slight increase in short circuit levels for three-phase and single – phase faults due to connection of Mehran Energy PP on the 132 kV bus bars in its vicinity. We find that even after some increase, these fault levels are below the rated short circuit values of the equipment installed on these substations. The maximum short circuit level of Mehran Energy PP 132 kV is 6.96 kA and 6.83 kA for 3-phase and 1-phase faults respectively.

6.4 Fault Current Calculations with Mehran Energy PP – Year 2021

Fault currents have been calculated for the electrical interconnection of proposed scheme in the year 2021. Fault types applied are three phase and single-phase 132 kV bus bars of Mehran Energy PP itself and other bus bars of the 132 kV substations in

the electrical vicinity of Hala Road, Tando Jam, Tand o Allah Yar, Chamber and Mirpur Khas. The graphic results showing maximum 3-phase and 1-phase fault levels are indicated in Exhibit 4.2. Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV bus bars of the network in the electrical vicinity of Mehran Energy PP are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.3

Table-6.3
Maximum Short Circuit Levels with Mehran Energy PP – Year 2021

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
MEL PP 132 kV	7.09	6.94
Chamber 132 kV	6.27	6.00
Shaikh Bhirkio 132 kV	4.62	4.66
Tandojam 132 kV	11.06	10.27
T. A. Yar 132 kV	10.10	9.81
Sultanabad 132 kV	12.56	12.05
Mirpurkhas 132 kV	15.33	16.51
Mirpurkhas-2 132 kV	10.38	10.60
MirpurKhas-PP 132 kV	9.42	9.53
Mir Wah Gurchani 132 kV	6.78	6.10
Kot GM 132 kV	5.56	5.27
Usman Shah Huri 132 kV	6.38	5.73
FPL PP 132 kV	4.73	5.01
Samaro 132 kV	6.30	6.56
Hala Road 132 kV	22.59	23.26
Hala Road-1 132kV	16.74	16.96

We find that the short circuit levels have increase a little more in the future scenario but are still below the rated short circuit values of the equipment installed on these substations. The maximum short circuit level of Mehran Energy PP 132 kV is 7.09 kA and 6.94 kA for 3-phase and 1-phase faults respectively. It would be advisable to go for standard size switchgear of short circuit rating of 40 kA. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.

6.5 Conclusion of Short Circuit Analysis

The short circuit analysis results show that for the proposed scheme of interconnection of Mehran Energy PP there is no problem of violations of short circuit ratings of the already installed equipment on the 132 kV equipment of substations in the vicinity of Mehran Energy PP due to fault current contributions from this power house under three-phase faults as well as single phase faults.

The short circuit level of the Mehran Energy PP 132 kV is 6.96 kA and 6.83 kA for 3-phase and 1-phase faults respectively for the year 2019. The same values for the year 2021 are 7.09 kA and 6.94 kA. Therefore industry standard switchgear of the short circuit rating of 40 kA would be fine to be installed at 132 kV switchyard of Mehran Energy PP taking care of any future generation additions and system reinforcements in its electrical vicinity and also fulfill the NEPRA Grid Code requirements specified for 132 kV Switchgear.

7. Dynamic Stability Analysis

7.1 Assumptions & Methodology

7.1.1 Dynamic Models

The assumptions about the generator and its parameters are the same as mentioned in Ch.2 of this report.

We have employed the generic dynamic models available in the PSS/E model library for dynamic modeling of the generator, exciter and the governor as follows;

Generator	GENROU
Excitation System	EXST1
Speed Governing System	TGOV1
Inertia Constant	H = 2.819 MW-sec/MVA

7.1.2 System Conditions

The proposed scheme as described in Chapter-4 has been modeled in the dynamic simulation.

All the power plants of WAPDA/NTDCL and IPPs from Tarbela to Hub have been dynamically represented in the simulation model.

7.1.3 Presentation of Results

The plotted results of the simulations runs are placed in Appendix-E. Each simulation is run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish the pre fault/disturbance conditions of the network under study were smooth and steady. Post fault recovery has been monitored for nine seconds. Usually all the transients due to non-linearity die out within 3-4 seconds after disturbance is cleared in the system.

7.1.4 Worst Fault Cases

Three phase faults are considered as the worst disturbance in the system. We have considered 3-phase fault in the closest vicinity of Mehran Energy PP i.e. right at the 132 kV bus bar of Mehran Energy PP substation, cleared in 5 cycles, as normal clearing time for 132 kV i.e.100 ms, followed by a permanent trip of single 132 kV circuit emanating from this substation.

7.2 Dynamic Stability Simulations' Results with Mehran Energy PP in Crushing Season

Three-phase faults were applied on 132 kV bus bars, followed by clearing of fault in 5 cycles (100 ms) or 9 cycles (180 ms) and then tripping of a circuit between the faulted bus and a nearby grid station. Different quantities were monitored for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and the results are plotted in Appendix – E. These fault locations and monitored quantities are discussed one by one as follows;

7.2.1

Fault Location: Three Phase Fault at Mehran Energy PP 132 kV bus bar			
Fault Duration: 5 cycles (100 ms)			
Line Tripping: Mehran Energy PP to Mirpurkhas 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. MEL PP 132 kV 2. Usman Shah 132 kV 3. Tando Allah yar 132 kV 4. MPKEL 132 kV 5. Mirpurkhas -2 132 kV 6. Mirpurkhas 132 kV	The voltages of all the bus bars recover after fault clearance	1.1
Frequency	Mehran Energy PP 11 kV	Recovers after fault clearance	1.2
MW/MVAR Output of the Plant	Mehran Energy PP 11 kV	Recovers after damping down oscillations	1.3
Speed and $P_{mechanical}$ of the Plant	Mehran Energy PP 11 kV	Recovers after damping down oscillations	1.4
Line Flows (MW/MVAR)	Mehran Energy PP to Usman Shah 132 kV intact single circuit	Attains steady state value after damping of oscillations	1.5
Rotor Angles	1. MPKEL PP 11 kV 2. MEL PP 11 kV 3. FPL PP 11 kV 4. Mir Wah PP 11 kV 5. Jamshoro 220 kV 6. Hub 500 kV (reference angle)	Damps down and attain a steady state value	1.6

7.2.2

Fault Location: Single Phase Fault at Mehran Energy PP 132 kV bus bar			
Fault Duration: 9 cycles (180 ms)			
Line Tripping: Mehran Energy PP to Mirpurkhas 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. MEL PP 132 kV 2. Usman Shah 132 kV 3. Tando Allah yar 132 kV 4. MPKEL 132 kV 5. Mirpurkhas -2 132 kV 6. Mirpurkhas 132 kV	The voltages of all the bus bars recover after fault clearance	2.1
Frequency	Mehran Energy PP 11 kV	Recovers after fault clearance	2.2
MW/MVAR Output of the Plant	Mehran Energy PP 11 kV	Recovers after damping down oscillations	2.3
Speed and $P_{mechanical}$ of the Plant	Mehran Energy PP 11 kV	Recovers after damping down oscillations	2.4
Line Flows (MW/MVAR)	Mehran Energy PP to Usman Shah 132 kV intact single circuit	Attains steady state value after damping of oscillations	2.5
Rotor Angles	1. MPKEL PP 11 kV 2. MEL PP 11 kV 3. FPL PP 11 kV 4. Mir Wah PP 11 kV 5. Jamshoro 220 kV 6. Hub 500 kV (reference angle)	Damps down and attain a steady state value	2.6

7.2.3

Fault Location: Three Phase Fault at Mirpurkhas 132 kV bus bar			
Fault Duration: 5 cycles (100 ms)			
Line Tripping: Mehran Energy PP to Mirpurkhas 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Mirpurkhas 132 kV 2. MEL PP 132 kV 3. Tando Allah yar 132 kV 4. MPKEL PP 132 kV 5. Mirpurkhas -2 132 kV 6. Usman Shah 132 kV	The voltages of all the bus bars recover after fault clearance	3.1

Frequency	Mehran Energy PP 11 kV	Recovers after fault clearance	3.2
MW/MVAR Output of the Plant	Mehran Energy PP 11 kV	Recovers after damping down oscillations	3.3
Speed and $P_{mechanical}$ of the Plant	Mehran Energy PP 11 kV	Recovers after damping down oscillations	3.4
Line Flows (MW/MVAR)	Mirpurkhas to Mirpurkhas-2 132 kV intact single circuit	Attains steady state value after damping of oscillations	3.5
Rotor Angles	1. MPKEL PP 11 kV 2. MEL PP (Mehran Energy Limited) 11 kV 3. FPL PP 11 kV 4. Mir Wah PP 11 kV 5. Jamshoro 220 kV 6. Hub 500 kV (reference angle)	Damps down and attain a steady state value	3.6

7.3 Conclusion of Dynamic Stability Analysis

The results of dynamic stability show that the system is very strong and stable for the proposed scheme for the severest possible faults of 132 kV systems near to and far of Mehran Energy PP. Therefore there is no problem of dynamic stability for interconnection of Mehran Energy PP; it fulfills all the criteria of dynamic stability.

8. Conclusions

- Grid Interconnection Study for 26.5 MW (Gross Capacity) Mehran Energy Limited PP is carried out which is located near Deh Daro Sutha Tando Adam Road, District Tando Allahyar. The nearest HESCO grid facility available for interconnection to Mehran Energy PP is existing 132 kV circuit between Mirpurkhas 132 kV Grid Station and Usman Shah 132 kV Grid Station.
- Keeping in view the location of Power Project, the most feasible interconnection scheme would be looping in-out the existing 132 kV circuit between Mirpurkhas to Usman Shah at Mehran-PP. The looping distance as confirmed from site visit would be 1 km and the conductor used would be Lynx. The scheme is shown in Sketch-2 in Appendix-B.
- Mehran Energy PP would generate power at 11 kV voltage level from where it is stepped-up to 132 kV using two 132/11 kV transformers with rating of 31.5/40 MVA.
- The proposed scheme would require two 132 kV line bays at the 132 kV substation of Mehran Energy PP for the connection of 132kV circuit to both Mirpurkhas and Usman Shah Grid stations. Furthermore it would also require two transformer bays for the connection of two 132/11 kV transformers with rating of 31.5/40 MVA.
- With the gross capacity of 26.5 MW, the spillover from Mehran Energy PP would be 23.75 MW in Off-Season and 21.11 MW in the Crushing Season.
- In view of planned COD of the Mehran Energy PP in November 2018, the above proposed interconnection scheme has been tested for steady state conditions through detailed load flow studies for the peak conditions of
    - January 2019 for maximum thermal power dispatches in the grid during the Crushing Season for Mehran Energy PP.
    - September 2019 for maximum hydropower dispatches in the grid during the off-season of Mehran Energy PP.

  The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.
- The proposed scheme of interconnection has also been tested for the extended term scenario of peak load conditions of the year 2021 for steady state conditions.

- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the spillover of up to 23.75 MW power of the Plant under normal as well as contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at Mehran Energy PP and the substations of 132 kV in its vicinity. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear installed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from Mehran Energy PP.
- The maximum short circuit levels of Mehran Energy PP 132 kV is 6.96 kA and 6.83 kA for 3-phase and 1-phase faults respectively for the Year 2019 and 7.09 kA and 6.94 kA for 3-phase and 1-phase faults respectively for the Year 2021. It would be advisable to go for standard size switchgear of short circuit rating of 40 kA. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.
- The dynamic stability analysis of proposed scheme of interconnection has been carried out for January 2019. The stability check for the worst case of three phase fault right on the 132 kV bus bar of Mehran Energy PP substation followed by the final trip of one 132 kV circuit emanating from this substation, has been performed for fault clearing of 5 (100 ms) and 9 cycles (180 ms), in case of stuck breaker, as understood to be the normal fault clearing time of 132 kV protection system. The stability of system for far end faults of 3-phase occurring at 132 kV bus bar have also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults for the most stringent cases. The system is found strong enough to stay stable and recovered with fast damping.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.