HYTEX
ENERGY (PVT) LTD.

Plot # B-5, S.I.T.E Area,
Hyderabad Pakistan.
Tel: +92-22-3883581
Fax: +92-22-3883504
E-mail: hytexenergy@gmail.com

The Registrar
National Electric Power Regulatory Authority
Islamic Republic of Pakistan
Islamabad

Ref HPD/KM001/2010
Date September 12, 2014

Dear Sir

APPLICATION FOR THE GENERATION LICENSE FOR HYTEX ENERGY (PVT) LTD. AT PLOT # B-5/A S.I.T.E HYDERABAD

I Khalid Malik Representative of HYTEX ENERGY (PVT) LTD being the duly authorized representative of HYTEX ENERGY (PVT) LTD, by virtue of dated September 08, 2014, hereby apply to the National Electric Power Regulatory Authority for the grant of Generation License to the HYTEX ENERGY (PVT) LTD at Plot # B-5/A S.I.T.E Hyderabad pursuant to section (15) of the Regulations Generation of Electric Power Act 1997.

I, certify that the documents in support attached with this application are prepared and submitted in conformity with the provision of the National Electric Power Regulatory Authority undertake to abide by the terms and provisions of the aforesaid regulations, I further undertake and confirm that the information provided in the attached document(s) in support is true and correct to the best of my knowledge and believe.

Bank Draft # 10577127 dated 12/04/2014 in the sum of Rs. 132,480/= (Rupees One Hundred Thirty Two Thousand Four Hundred and Eighty 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 Regulation 1999 is also attached herewith

Thanking you

For HYTEX

Khalid Malik

Encl: As stated above

A001976

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. **0089555**

I hereby certify that **HYTEX ENERGY (PVT.) 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 **Twentieth** day of **August,** Two **Thousand** and **Fourteen**.

Incorporation fee Rs. **404,000/=** only

(Sidney Custodio Pereira)
Joint Registrar of Companies
Karachi

THE COMPANIES ORDINANCE, 1984

(XLVII OF 1984)

(PRIVATE COMPANY LIMITED BY SHARES)

MEMORANDUM

AND

716025
Securities & Exchange Commission of Pakistan
19 AUG 2014
CRO KARACHI

ARTICLES OF ASSOCIATION

OF

HYTEX ENERGY (PRIVATE) LIMITED

Company Registration Office Karachi
Securities and Exchange Commission of Pakistan
SECP

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Secretary
HYTEX ENERGY (PVT) LTD

(The Companies Ordinance, 1984)

Company Limited by Shares

Memorandum of Association

Of

HYTEX ENERGY (PRIVATE) LIMITED

I. The name of the company is **"HYTEX ENERGY (PRIVATE) LIMITED".**

II. The registered office of the company will be situated in the Province Sindh.

III. The objects for which the Company is established are all or any of the following:-

1. To carry on business of producing electricity for the purpose of in house consumption and for sale of Electricity to the government Grid/ DISCO or to supply other Industries through wheeling.

2. To carry on business of Generation of electrical energy and any other actives of Transmission and Distribution of electricity to other Industries produced by our own power plant.

3. To carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting of cloth and dealing in electricity and all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation and supply.

4. To carry on the business to install power station to generate electricity for in house consumption and to supply electricity to sister concern industries and to sell surplus electricity to DISCOS (Government Gird).

5. To locate, establish, construct, equip, operate, use, manage and maintain and install power plant, more then 10MW as (N-CPP) thermal power plants and coal fired

power plants, power grid station with transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centers, shops, dispensing machines for pre-payment cards and other devices, showrooms, depots, factories, workshops, plants, printing facilities, warehouses and other storage facilities, and to sell electricity to concern DISCOS/ Central Power Purchases Agency.

6. To carry on all or any of the businesses of manufacturing of Fabrics, export of cloths, spinning, weaving, dying and printing, cotton ginning ,wholesalers, retailers, traders, importers, exporters, suppliers, distributors, designers, developers, manufacturers, installer, filters, testers, repairers, maintainers, contractors, constructors, operators, users, inspectors, recondition, improvers, alterers, protectors, removers, hirers, replacers, importers and exporters and dealers in, electrical appliances, systems, products and services used for energy conservation, equipments, machinery, materials and installations, including but not limited to cables, wires, meters, pylons, tracks, rails, pipelines and other plant, apparatus equipment, systems and things incidental to the efficient generation, procurement, transformation, supply and distribution of electricity with in the country and outside the country.

7. To carry on import CKD kit of generators set for the purpose of manufacturing electric generators in Pakistan.

8. To carry on business of manufacture electric generators for local sale and for export.

9. To carry on business to import electric generators and other allied parts to sale in the local market as indenters/ importer.

10. To carry on business to install and manufacturing drinking mineral water plant to sale in local market in different packing size.

11. To carry on business to rent out generators on daily monthly & yearly basis of any size required by client.

12. To carry on business to give our Techno commercial assistance to our client for trouble shooting and to carry out scheduled maintenance of generators.

13. To ascertain the tariff for bulk supply that will secure recovery of operating costs, interest Charges and depreciation of assets, redemption at due time of loans other than those covered by Depreciation, expansion projects, payment of taxes and reasonable return on investment, to quote The tariff to bulk purchasers of electrical

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HYTEX ENERGY (PVT) LTD

power, and to prefer petition to the appropriate authority for approval of the schedule of tariff and of adjustments or increases in its bulk supply tariff, where desirable or necessary.

14. To receive goods on consignment, from any company, firm, association of persons, body, individuals, government, semi-government or any local authority and sell the same as agents or as principal.

15. To establish, purchase, take on lease or otherwise acquire and run shops, showrooms, trading outlets, distributing centers or depots at any place in Pakistan and/or abroad.

16. To carry on the business of inventors and to conduct and to promote the conduct by other persons of research and development in connection with any of the activities of the company authorized in this memorandum and in any other area which might benefit the business of the company or of persons having or likely to have dealings with the company; to establish, maintain and operate research stations, laboratories, plants, workshops, field stations, testing sites, facilities and establishments and generally to engage in research and development for the company and for other persons and to turn account the results thereof.

17. To purchase, take on lease or sub-lease or tenancy or in exchange, hire, take options, over or otherwise acquire for any estate or interest whatsoever and to hold, develop, work, cultivate, deal with and turn to account concessions, grants, decrees, licenses, privileges, claims, options, leases, property, real or personal or rights or powers of any kind which may appear to be necessary or convenient for the business of the company.

18. To take up and work agencies (except managing agents), representation, and distribution for principals, manufacturers, sole agents or distributors for their own products, commodities, or for other persons, firms, companies or corporations.

19. To obtain concessions, leases, rights, privileges, permission and patent rights, and like, periodical or otherwise which may be conducive to the interest of the business of the company, from any Governments, States, Municipalities, Local Boards, Trusts and other Authorities, supreme or otherwise, or from any other public or private Company, to enter into arrangements or engagements, in any connection therewith and to carry on, use exercise, subject and comply with such rights, privileges, concessions, permission and arrangements.

20. To carry on the business of manufactures, repairers, renovators, of and dealers (wholesale and retail) in new or used machineries, engineers, boilers, installations, plant and equipment, apparatus, and instruments, of all kinds, as required and necessary for the aforesaid objects and purposes.

21. To carry on any other trade or business which can in the opinion of the company, be advantageously or conveniently carried on by the company by way of extension of or in connection with such business, if calculated directly or indirectly to develop any branch of the company's property, assets or rights.

22. To undertake and to carry into effect or manage for or jointly with others all such financial, trading, or manufacturing operations of business as the Directors of the Company think fit.

23. To apply for , purchase and otherwise acquire any patent brevets d' invention, concession, trade mark and like, conferring and exclusive or nonexclusive or limited right to use, or any secret or any other information as to any invention which may seem capable of being used for any of the purposes of the company the acquisition of which may seem calculated, directly or indirectly, to benefit the company, and to use, exercise, develop, grant licenses in respect of them and turn to account the property, rights and information so acquired.

24. To enter into any contracts, agreement and arrangement with any Government Authorities, Supreme, Municipal, Local or otherwise which may seem conducive to any of the Company's objects and to obtain from any such Government or other Authority any rights, privileges and concessions, which may appear desirable such contracts, agreement, arrangements, rights, privileges, and concessions and to oppose the grant of any such rights, privileges or concessions to others.

25. To act as contractor or subcontractors, to any local, provincial or Central Government, State or other Railways, Port Trusts, Municipal Corporations or Municipalities, District Local Boards, Civil and Military authorities and any person or persons, firm and corporation for any purpose whatsoever and to guarantee supply of the articles dealt with by the Company.

26. To apply for, tender, purchase or otherwise acquire any contracts and concession for or in relation to the manufacture, import, export, carrying out, equipment,

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improvement, of articles dealt with by the Company and to undertake, execute, carry out dispose of or otherwise turn to account the same.

27. To sublet all or any of the contracts from time to time and upon such terms and conditions as may be through expedient.

28. To acquire and undertake the whole or any part of the business, good will and assets of any persons, firm or company carrying on or proposing to carry on any of the businesses which this Company is authorized to carry on and as part of the consideration for such acquisition, to undertake all or any of the liabilities of such person, firm or corporation or to acquire an interest in, amalgamate with or enter into any arrangement for sharing profit or for cooperation or for eliminating competition or sharing profit or for cooperation or for eliminating competition or for mutual assistance with any such persons, firm or company or things aforesaid or for any property acquired, any shares, debentures, or securities, that may be agreed upon and to hold and retain or sell, mortgage and deal with any shares, debentures, or securities so received.

29. To promote any company or companies for the purposes of acquiring all or any of the property, rights and liabilities of this company, or for any other purpose which may seem directly or indirectly, calculated to benefit this company.

30. To purchase, take on lease, or in exchange, hire or otherwise acquire real or personal, property moveable or immovable either in Pakistan or abroad and/or any rights or privileges which the company may think necessary or convenient for its purposes and operations, and in particular any land, building, factories, basements, machinery, plants and stock in trade.

31. To appoint engage, enter into agreement or arrangement with persons or companies for the purpose of acting as Agents (except managing agents) to the company on terms and conditions which the directors may deem fit.

32. To communicate with Chambers of Commerce and Industry and other Mercantile and Public Bodies in Pakistan and elsewhere, and convert and promote measures for the protection and advancement of trade, industry and commerce and other facilities.

33. To sell, improve, develop, change, let (on lease or otherwise), mortgage, and otherwise dispose of, deal with and turn to account all or any part of the undertaking property and rights of the company, for such consideration as may be through fit and accept for such consideration to be received by the company money or shares or debentures or debenture–stock or other securities of any other company or companies.

34. To enter into partnership or into any agreements for sharing profits, union of interest, reciprocal concessions, amalgamation or cooperation or joint venture with any person or persons corporation or company, carrying on or about to carry on or engage in any business, transaction which this company is authorized to carry on or engage in any business, transaction capable of being conducted so as, directly or indirectly, to benefit this company, and to take or otherwise acquire and hold shares or stock in or securities of and to subsides or otherwise assist any such company, and to sell, hold, reissue with or without guarantee, or otherwise deal in such shares or securities, and to form, constitute or promote any other company or rights and liabilities of the company or of any other purpose which may seem directly or indirectly, calculated to the benefit of the company.

35. To amalgamate with any company whose objects are, or include objects similar to those o the company altogether or in part whereby sale, or purchase (for fully paid up shares) of the undertaking subject to the liabilities of this or by sale or purchase (for fully paid up shares) of all the shares or stock of this or any such other company as aforesaid or by partnership or any arrangements of the nature of partnership or in any other manner.

36. To expend any of the monies of the company in exhibiting or otherwise advertising or making know the business and products of the company and to make any arrangements for the payment of commissions or shares of profits to or otherwise remunerating any person or company so advertising or making known such business or products.

37. To get insured with any person or company against losses, damages, risks, and liabilities of any kinds, which may affect the company either wholly or partly and if through fit to effect any such insurance by joining or becoming members of any such insurance, protection, or indemnity association, federation or society, and to accept any such insurances or party thereof for the account of the company.

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BYTEX [illegible] (PVT) LTD.

38. To create any depreciation fund, reserve fund, sinking fund charity fund, insurance fund, or any other special fund, whether for depreciation or for repairing, improving, extending or maintaining any of the property of the company, or for any other purpose conducive to the interests of the company.

39. To pay all or any costs, charges and expenses whatsoever, preliminary, incidental, or in relation to the promotion, formation, registration or establishment of this or any other company, or to the raising of subscription, issue, settlement, or quotation upon any exchange, of any portion of the original or future shares, loan or other capital of this or any other company, and to remunerate by commission, discount or otherwise any person or company for services rendered in placing or assisting to place any of such capital, debenture, debenture stock or securities, or obtaining or assisting to obtain a settlement or quotation of the same upon assisting to obtain a settlement or quotation of the same upon any exchange for any services preliminary, incidental or relating to, or inc connection with, the promotion, formation, registration, or establishment of this or any other company and to charge any payment or remuneration aforesaid to capital or revenue.

40. To buy, sell, acquire, and deal in all kinds of shares, share stock, debenture stocks, bonds, obligations and Government securities issued or guaranteed b Company constituted, established or carrying on business in Pakistan, or elsewhere or issued or guaranteed by any government, state dominion, ruler, public body or authority or issued or guaranteed by any firm, company, persons or business in Pakistan or else where.

41. To receive money on deposit at interest or otherwise, and to lend and advance money to such person and companies an on such terms as may be deemed expedient only in furtherance of main objects of the company.

42. To raise and borrow money and secure the payment of money by such means, upon such terms and conditions, and in such manner as may be determined, and particularly by the creation or issue of bonds, mortgage, debentures, debenture-stocks, or other securities, either perpetual or terminable, and charged specifically or by way of floating charge or otherwise, upon all or any party of the undertaking, property, and rights of the company (either present of future or both) ~~including~~, its

capital or not entitled to any charges and to redeem, purchase, or pay of any such securities.

43. To remunerate any person or company for services rendered to be rendered or in placing or assisting to placing or assisting to place or guaranteeing the placing of any of the shares in the company's capital or any debenture stock or there securities of the Company, or in or about the formation or promotion of the Company or the conduct of its business.

44. To draw, make, accept, endorse, execute, negotiate, purchase, upon discount, hold any dispose of cheques, promissory notes, bills of exchange, drafts, charter parties bills of lading, warrants and other negotiable documents and contracts, deeds and other instruments.

45. To lay out, advance, invest to the company's surplus money with or to such person or company and in or upon such investments or securities, and generally in such manner as from time to time be determined, and to appoint any person or company to accept and hold in trust for the company any property of the company and to remunerate any such person or company, and instead of itself holding any property, to hold all or any of the shares in any company whether in Pakistan or outside which may or may not hold such property.

46. To invest the surplus moneys of the Company not immediately required in such manner as may from time to time be determined.

47. To promote and launch any product of the company and get registered or recognized in any foreign country or place in any part of the world.

48. To sell, improve, manage, develop, exchange, lease, mortgage, enfranchise, dispose of turn to account, or otherwise deal with all or any part of the property and right of the Company.

49. To provide for the welfare of the employees of the Company and their wives, windows, children, orphans and families or dependents or connection of such persons by building or contributing to the to the building of house, dwelling, or chawls or by grants of money , pensions, allowances, bonus or other payments or by creating from time to time, subscribing or contributing to provident and other

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associations, institutions, funds or trust and by providing or subscribing or contributing towards places of instruction and recreating hospitals and dispensaries, medical and other assistance as the Company shall thinks fit, and to subscribed or contribute or otherwise to assist or to guarantee money to charitable, benevolent, religious, scientific, public or claims to support and or aid by the Company either by reason of locality of operation or public or general utility or otherwise.

50. To distribute among the shareholders in specie, any property of the company, whether by way of dividend or upon a return of capital but so that no distribution amounting to a reduction of capital be made except with the sanction for the time being required by law.

51. To do all such other things as may be necessary, incidental conducive or convenient to the attainment of the above objects or ay of them, in any party of the word, as principals, agents (except managing agents) contractors or otherwise, and by or their agents, or otherwise, and either alone or in conjunction with others.

52. To open, maintain, adjust state or close account or accounts of every description with any firm or company or bank or bankers or shroffs and to pay into and o withdraw money from such account or accounts and to do all acts necessary from the purposes.

53. To guarantee the performance of contracts, agreements, obligations or discharge of any debt of the Company or on behalf of any company or person in relation to the payment of 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 or any or all of the movable and immovable properties of the Company, either present or future or both and issuance of any other securities by any other means in favour of banks, Non-Banking Finance Companies (NBFC's) or any financial institutions and to borrow money for purpose of the Company on such terms and conditions as may be considered proper.

54. To issue and execute guarantee/guarantees for and on behalf of the Company to secure its liability or for any associated Company incorporated under the relevant provisions of law in favour of any banks, DFI's, financial institution or government agency and to offer the assets of the Company as security to the said bank or

financial institutions and to create a charge or lien against the assets of the Company making itself liable as guarantor in the transaction of the said associated Company with the banks, DFI's or the financial institution/government agencies.

55. To purchase, hold and get redeemed shares, debentures, bonds of any business, company, financial institutions or any Government institutions.

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

57. It is hereby declared and undertaken that the Company shall not engage in banking business, business of an investment company, non-banking finance company, leasing, business of managing agency, investment, payment sales receipt scheme and insurance business directly or indirectly as restricted under the law or in any unlawful business or operations and that nothing contained in the object clauses shall be so construed to entitle it to engage in such businesses directly or indirectly and the Company shall not launch multilevel marketing (MLM), Pyramid and Ponzi schemes.

IV. The liability of the member is limited.

V. The Authorized Capital of the company is Rs50,000,000 /- (Fifty Million) divided into 5,00,000 ordinary shares of Rs.100/- each with power to increase, reduce consolidate or otherwise re-organize the Share capital and to divide the shares of the company into different classes in accordance with the provision of the Companies Ordinance, 1984.

Company Registration Office Karachi
Securities and Exchange Commission of Pakistan
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[illegible] ENERGY (PVT) LTD.

We, the several persons, whose names are appended below, are desirous to form a company pursuant to the Memorandum of Association, and we respectfully agree to take the number of shares in the capital of the company set opposite to our respective names.

Name and surname (Present & Former) in Block Letter. With full Address	Father/Husband Name in Full.	Nationality	Occupation	No. of Shares	Signature
ABDUL SATTAR KHAN HOUSE NO.GR/381,MUHALLA JHANGIR PADA HALI ROAD HYDERABAD CNIC No. 41304-6498907-7	ABDUL JABBAR KHAN	PAKISTANI	BUSINESS	90000 (Ninety Thousand)	
SYED ZULFIQAR ALI SHAHEEN ARCADE FLAT NO.F-15. MUHALLA UNIT NO. 8, LATIFABAD HYDERABAD CNIC No. 42101-1007795-7	SYED IFTIKHAR ALI	PAKISTANI	BUSINESS	75000 (Seventy five Thousand)	
DANISH HOUSE NO.113/C. MUHALLA UNIT NO. 10 LATIFABAD HYDERABAD CNIC NO. 41304-5337603-7	MUHAMMAD JAMEEL AHMED KHAN	PAKISTANI	BUSINESS	45000 (Forty Five Thousand)	
UMER HASSAN QADRI HOUSE NO.149 BLOCK "E" MUHALLA UNIT NO. 6 LATIFABAD HYDERABAD CNIC No. 41304-2301797-9	SIDDIQUE HASSAN QADRI	PAKISTANI	BUSINESS	30000 (Thirty Thousand)	
MUHMMAD ALI HASSAN HOUSE NO.149 BLOCK "E" MUHALLA UNIT NO. 6 LATIFABAD HYDERABAD. CNIC No. 41304-288371-3	SIDDIQUE HASSAN QADRI	PAKISTANI	BUSINESS	30000 (Thirty Thousand)	
MRS. MINHAJ ALI HOUSE NO. 149 BLOCK "E" MUHALLA UNITNO. 6 LATIFABAD HYDERABAD. CNIC No. 41304-2223657-8	MUHMMAD ALI HASSAN	PAKISTANI	BUSINESS	15000 (Fifteen Thousand)	
ADEEL AHMED KHAYYAM HOUSE NO.31/III/I MUHALLA 32 SABA AVENUE FAIZ DHA-EXT-V, KARACHI CNIC No. 41304-6784487-1	SHOUKAT KHAYYAM	PAKISTANI	BUSINESS	15000 (Fifteen Thousand)	
			TOTAL	**300,000**	

(Three Hundred Thousand Shares)

TOTAL SAHRES 300,000
Dated the 25th day of July 2014

Company Registration Office Karachi
Securities and Exchange Commission of Pakistan
SECP

Serial No.....
Name of the Company.....
Brief Description of the document including ~~or enclosed~~.....
The date on which the document is registered filed or reconed....

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21/8/14
Asst Joint Registrar of Companies

Joint Registrar of Companies
Companies Registration Office
Karachi.

Witness to above signatures.

Full name: ZEESHAN AMBER

NIC N/o 41304-3783349-3

Occupation: Private Service

Father/ Husband name MUHAMMAD BASHIR SIDDIQUI NIHAL

Full Address HOUSE No: 17MUHALLAH NEAR GAZALI COLLEDGE UNIT No: 11

LATIFABAD HYDERABAD.

Company Registration Office Karachi
Securities and Exchange Commission of Pakistan
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THE COMPANIES ORDINANCE, 1984
(PRIVATE COMPANY LIMITED BY SHARES)
ARTICLES OF ASSOCIATION
OF
HYTEX ENERGY (PVT) LIMITED

PRELIMINARY

1. The regulations contained in Table 'A' of the First Schedule of the Companies Ordinance, 1984 shall apply to this Company (so far as these regulations are applicable to Private Companies) except as the same are modified, altered repeated or added to by these Articles.

DEFINITIONS AND INTERPRETATIONS

2. In these Presents unless there be something in the subject or context inconsistent therewith, words signifying the singular number only, shall include the plural and Vice Versa and words signifying males only shall extend to and include females and words signifying persons shall apply mutates mutandis to bodies corporate.

a) "The Company" means **"HYTEX ENERGY (PVT) LIMITED**

b) "The Office" means the "registered office of the Company for the time being".

c) "Section" means "Section of the Ordinance".

d) "Ordinance" means the Companies Ordinance, 1984"

e) "Month and year" shall mean "the English Calendar month and English calendar year respectively".

f) "The Register" means "the register of members to be kept pursuant to Section 147 of the Companies Ordinance, 1984".

g) "In writing or written" includes printed, lithographed and typewritten or other modes of representing words in visible and legible form.

h) "Dividend" includes bonus shares.

i) "Special Resolution" shall have the meaning assigned thereto by section 2(36) of the Ordinance.

j) "Capital" shall mean the Capital of the Company for the time being raised or authorized to be raised for the purpose of the Company.

k) "Shares" shall mean the shares in the capital of the Company for the time being.

l) "These Present" shall mean the Memorandum of Association of the Company and these Articles and supplementary, substituted or amended Articles for the time being in force.

m) "The Seal" in relation to a Company means the Common Seal of the Company.

PRIVATE COMPANY

3. The Company is a Private Company within the meaning of Section 2 Sub Clause (28) of the Companies Ordinance, 1984, and accordingly :-

a. No invitation shall be issued to the public to subscribe for any shares, debenture or debentures stock of the Company.

b. The number of the members of the Company (exclusive of the persons in employment of the Company) shall be limited to 50 provided that for the purpose of this provision where two or more persons hold one or more shares jointly they shall be treated as a single member, and

c. The right to transfer shares of the Company is restricted in the manner provided hereunder.

CAPITAL

4. The authorized capital of the Company is Rs.50, 000,000/- (Rupees Fifty Million Only) divided into 5, 00,000 (Five Lac) Ordinary Shares of Rs.100/- each with the rights, privileges and conditions attaching thereto as are provided by regulation of the company for the time being, with powers to increase, reduce, consolidate, sub-divide, re-organized or divide the share capital of the Company into several classes and kind in accordance with the provisions of the Companies Ordinance, 1984.

SHARES

5. Subject to the provisions of the Ordinance, the shares shall be under the control of the Board of Directors who may allot or otherwise dispose of the same to such person, firms or Corporations, on such terms and conditions and for such considerations and at such times as may be thought fit.

6. The shares in the Capital of the Company may be allotted or issued in payment or part payment of any land, building, machinery, or goods supplied or any services rendered to the Company in promotion and establishment thereof or in conduct of its business any share so allotted may be issued as fully paid up and not otherwise.

7. If a share certificate is defaced, lost or destroyed, it may be renewed on payment of such fee, and on such terms, as to evidence and indemnity and payment of expenses incurred by the Company investigating title as the Directors think fit.

8. Where at any time the Board decides to increase the issued capital of the Company by issuing any further shares, then subject to provisions of Section 86 of the Companies Ordinance, 1984, all new shares shall be offered 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 the members 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/she declines to accept the shares offered, the Board may dispose of the same in such manner as it may consider most beneficial to the Company.

TRANSFER OF SHARES

9. The instrument of transfer of any share in the Company shall be executed both by the transferor and transferee, and the transferor shall be deemed to remain holder of the share until the name of the transferee is entered in the register of members in respect thereof.

10. Shares in the Company shall be transferred in the form prescribed by Table "A" in First Schedule or in any usual or common form, which the Directors shall approve.

11. The Directors shall not refuse to transfer any fully paid shares unless the transfer deed is defective or invalid. The Directors may also suspend the registration of transfer during the

ten days immediately preceding a general meeting or prior the determination of entitlement or rights of the shareholders by giving seven days previous notice in the manner provided in the Ordinance. The Directors may decline to recognize any instrument of transfer unless ;

a. A Fee as may be determined by the Directors is paid to the Company in respect thereof and:

b. The duly stamped instrument of transfer is accompanied by the certificate of the shares to which it relates, and such other evidence as the Directors may reasonably require showing the right of the transferor to make the transfer.

12. If the Directors refuse to register a transfer of shares, they shall within one month after the date on which the transfer deed was lodged with the Company send to the transferee and the transferor notice of the refusal indicating the defect or invalidity to the transferee, who shall after removal of such defect or invalidity reloaded the transfer deed with the Company.

TRANSMISSION OF SHARES

13. The executors, administrators, heirs or nominees, as the case may be, of a deceased sole holder of a share shall be the only person recognized by the company as having any title to the shares. In the case of a share registered in the names of two or more holders, the survivors or survivor, or the executors or administrators of the deceased, survivor shall be the only persons recognized by the Company as having any title to the share.

14. Any person becoming entitled to a share in consequence of the death or insolvency of a member shall, upon such evidence being produced as may from time to time be required by the Directors having the right either to be registered as a member in respect of the share or, instead of being registered himself; to make such transfer of the shares as the deceased or insolvent person could have made, but the Directors shall, in either case, have the same right to decline or suspend registration as they would have had in the case of a transfer of the share by the deceased or insolvent person before the death or insolvency.

15. A person becoming entitled to a share by reason of the death or insolvency of the holder shall be entitled to the same dividends and other advantages to which he would be entitled if he were the registered holder of the share, except that he shall not, before being registered as a member in respect of the share, be entitled in respect of it to exercise any right conferred by membership in relation to meetings of the Company.

ALTERATION OF CAPITAL

16. The Company, may from time to time, by special resolution increase the share capital by such sum, to be divided into shares of such amount, as the resolution shall prescribe.

17. Subject to the provision of the Ordinance, all new shares shall, before issue, be offered to such persons as at the date of the offer are entitled to receive notice from the Company of general meeting in proportion, as nearly as the circumstances admit, to the amount of the existing share to which they are entitled. The offer shall be made by notice specifying the number of shares offered and limiting a time within which the offer is not accepted, will be deemed to be declined and after the expiration of that time, or on the receipt of an intimation from the person to whom the offer is made that he declines to accept the shares offered, the Directors may dispose of the same in such manner as they think most beneficial to the Company. The Directors may likewise so dispose of any new shares which (by reason of the ratio which the new share bear to shares held by persons entitled to an offer of new shares) cannot in the opinion of the Directors, be conveniently offered under this regulations.

18. 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.

19. The Company may, by special resolution :

a. Consolidate and divide its share capital into shares of larger amount than its existing shares.

b. Sub-divide its existing shares or any of them into shares of smaller amount than is fixed by the Memorandum of Association subject, nevertheless to the provision of clause (d) of sub-section (1) of section 92;

c. Cancel any shares which, at the date of the passing of the resolution have not been taken or agreed to be taken by any person.

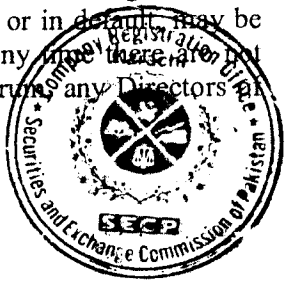
20. The Company may by special resolution, reduce its share capital in any manner and with, and subject to, any incident authorized and consent required by law.

GENERAL MEETING

21. The first general meeting to be called annual general meeting, shall be held, within 18 months from the date of its incorporation in accordance with provisions of section 158 and thereafter once atleast in every year and within a period of four months following the close of its financial year and not more than fifteen months after the holding of its last preceding annual general meeting as may be determined by the Directors.

22. All general meetings of the Company other than the Annual General Meeting mentioned in sections 157 & 158 shall be called extra ordinary general meeting.

23. The Directors may, whenever think fit, call an extra ordinary general meeting and extra ordinary general meetings shall also be called on such requisition, or in default, may be called by such requisitions, as is provided by section 159. If at any time there are not within Pakistan sufficient Directors capable of acting to form quorum, any Directors or



the Company may call an extra ordinary general meeting in the same manner as nearly as possible as that in which meeting may be called by the Directors.

PROCEEDINGS AT GENERAL MEETINGS

24. Subject to the provisions of sub-Section (3) of section 158 of the Companies Ordinance, 1984 at least 21 days' notice (exclusive of the day on which the notice is served) specifying the place, the date and the hour of meeting and, in case of special business, the general nature of that business shall be given to such person as are under the Companies Ordinance, 1984 or the regulations of the Company, entitled to receive such notice from the Company, but the accidental omission to give such notice to or the non-receipt of such notice by any member shall not invalidate the proceedings to any General Meeting.

25. All business shall be deemed special that is transacted at an Extra Ordinary General Meeting and also all that is transacted at an Annual General Meeting with the exception to declaring a dividend, the consideration of accounts, balance sheet and the reports of the Directors, and Auditors, the election of Directors, the appointment and fixing of remuneration of the Auditors.

26. No business shall be transacted at any General Meeting unless a quorum of members is present at the time when the meeting proceeds to business, save as or herein otherwise provided. Two members present in person representing not less than 25% of total voting power either in their own account or as proxy shall form a quorum for a General Meeting.

27. If within half an hour from the time appointed for the meeting a quorum is not present, the meeting if called upon the requisition of members shall be dissolved, in any other case, it will stand adjourned to the same day in the next week at the same time and same place and if at the adjourned meeting, a quorum is not present within half an hour from the time appointed for the meeting, the members present being not less than two shall be a quorum.

28. The Chairman of the Company shall preside as Chairman at every General Meeting of the Company.

29. If there is no such Chairman or if at any meeting he is not present within fifteen minutes, at the time appointed for holding the meeting or is unwilling to act as Chairman, the members present shall choose one of their members to be the Chairman.

30. 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 other than the business left unfinished of the meeting from which the adjournment took place; when a meeting is adjourned for ten (10) days or more, notice of the adjournment shall be given as in the case of an original meeting. Save as aforesaid, it shall not be necessary to give any notice of an adjournment or of the business to be transacted at an adjourned meeting.

31. At any General Meeting, a resolution put to the vote of the meeting shall be decided on a show of hands unless a poll is (before or on the declaration of the result of the show of hands) demanded. Unless a poll is so demanded, a declaration by the Chairman, that a

resolution has on show of hands been carried or carried unanimously or by a particular majority or lost and an entry to that effect in the books of the proceedings of the Company shall be conclusive evidence of the fact, without proof of the number of proportion or the votes recorded in favour of, or against that resolution.

32. If a poll is demanded as aforesaid, it shall be taken in the manner as provided under section 167 and 168 of the Ordinance.

33. In the case of an equality of votes whether on a show of hands or on poll, the Chairman of the Meeting at which the show of hands takes place or at which the poll is demanded, shall be entitled to have and exercise a second or casting vote.

34. A poll demanded on the election of Chairman or on a question of adjournment shall be taken at once.

VOTES OF MEMBERS

35. Subject to any rights or restrictions for the time being attached to any class or classes of shares. On show of hands every member present in person shall have one vote except for election of Directors in which case the provisions of section 178 shall apply, on a poll every member shall have voting rights as laid down in section 160.

36. In case of joint-holders the vote of the senior who tenders a vote, 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 the names stand in the register of members. In case of minor the guardian shall be entitled to vote for him.

37. 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 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.

38. On a poll, votes may be given either personally or by proxy provided that no body corporate shall vote by proxy as long as a resolution of its Directors in accordance with the provision of Section 162 of the Companies Ordinance, 1984 is in force.

39. The instrument appointing a proxy shall be in writing under the hand of the appointer or by his attorney authorized in writing if the appointer is a corporation either under the common seal, or under the hand of an officer or attorney so authorized. No person shall act as a proxy unless he is a member of the Company.

40. 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 registered office of the Company not less than forty eight hours before the time for holding the meeting at which the person named in the instrument proposes to vote and in default the instrument of proxy will not be treated as valid.

41. An instrument appointing a proxy may be in the following form or in any other form near thereto as may be approved by the Company.

HYTEX ENERGY (PVT) LIMITED

I _____ of _____ in the district of _____ being a member of the "**HYTEX ENERGY (PVT) LIMITED**" hereby appoint Mr._____ of _____ as my proxy to vote for me and on my behalf at the Annual General Meeting or Extra Ordinary General Meeting of the Company to be held on _____ day of _____ and at any adjournment thereof.

Dated : _____ Signature _____

42. 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 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.

DIRECTORS

43. The Directors of the Company shall subject to Article clause 44 hereof, fix the number of elected Directors of the Company not later than 35 days before convening of the General Meeting at which Directors are to be elected and the number so fixed shall not be changed except with the prior approval of the General Meeting of the Company.

44. Unless otherwise determined by the Company in General Meeting in the manner provided under Article clause 43, the number of Directors shall not be less than two and more than fifteen.

The following are First Directors of the Company who shall hold office till first Annual General Meeting.

1. ABDUL SATTAR KHAN
2. SYED ZULFIQAR ALI
3. DANISH
4. UMER HASSAN QADRI
5. MUHMMAD ALI HASSAN
6. MRS. MINHAJ ALI
7. ADEEL AHMED KHAYYAM

Company Registration Office Karachi
Securities and Exchange Commission of Pakistan
SECP

45. The directors of the Company shall, unless the number of person who offer themselves to be elected is not more than the number of Directors fixed under Articles Clause 43 and 44 be elected by the members of the Company in General Meeting in the following manner namely:-

a. a member shall have such number of votes as is equal to the product of the number of voting shares or securities held by him and the number of Directors to be elected;

b. a member may give all his votes to a single candidate or divide them between more than one of the candidates in such manner as he may choose; and

c. The candidate who gets the highest number of vote shall be declared elected as Directors 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.

46. All elected Directors shall retire from office at the General Meeting held after every three years. A Director retiring at a meeting shall retain office until the election of Directors in that meeting.

47. Subject to the provision of Section 181 of the Companies Ordinance, the Company may by resolution in General meeting remove a Director appointed under Article clause 53 or elected in the manner provided for in Article clause 45 hereof.

48. In addition to the Directors elected or deemed to have been elected by shareholders, the Company may have Directors nominated by the Company's creditors or other special interest holders by virtue of contractual arrangements.

49. Save as provided in Section 187, no person shall be appointed as a Director unless he is member of the Company.

50. The Directors of the Company elected under Article clause 45 shall hold office for three years except the Directors appointed against casual vacancy who shall be subject to retirement in term of Article clause 53 hereof.

51. A retiring Director shall be eligible for re-election.

52. Subject to the provisions of the Ordinance, the Company may from time to time in General Meeting increase or decrease the number of Directors at time of election..

53. Any casual vacancy occurring on the Board of Directors may be filled up by the Directors but the person so chosen shall be subject to retirement at the same time as if he had become a Director on the day on which the Director in whose place he is chosen was last elected as Director.

REMUNERATION

54. Subject to the provisions of the Companies Ordinance, the remuneration of Directors including Chief Executive shall from time to time be determined by the Company in board meeting.

55. The Directors may also sanction the payment of such additional sum, as they may think fit to any Director for the performance of extra services he may render to the Company subject to the approval of the directors at the Board Meeting in accordance with the provisions of the Companies Ordinance, 1984.

56. The Director who resides out of station shall also be entitled to be paid such traveling expenses as may be fixed by the Directors from time to time.

57. The Directors may from time to time appoint any one of them to the office of the Director-in-charge/General Manager for such terms and at such remuneration as they may think fit.

QUORUM

58. The quorum necessary for the meeting of Board of Directors shall be fixed by the Directors and unless so fixed shall be Two Directors present in person.

59. Subject to the provisions of the Ordinance, a resolution in writing signed by all the Directors, without a meeting of Directors shall be effective for all purposes as a resolution passed at the meeting of Directors duly held, called and constituted.

DISQUALIFICATION OF DIRECTORS

60. No person shall become a Director of the Company if he suffers from any of the disabilities or disqualifications mentioned in Section 187 and if, already a Director shall cease to hold such office from the date he so becomes disqualified or disabled.

61. All acts done by any meeting of Directors or by a Committee of Directors or by any person acting as a Director shall, notwithstanding that it shall afterwards be discovered that there was some defect in the appointment of such Director, or person acting as aforesaid, as they or any of them were disqualified, be as valid as if every such person had been duly appointed and was qualified to be a Director.

POWERS AND DUTIES OF DIRECTORS

62. The business of the Company shall be managed by the Directors who may pay all expenses incurred in promoting and registering the Company and 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 these regulations required to be exercised by the Company in the General Meeting subject nevertheless to be provisions of the Ordinance or to any of these regulations, and such regulations being not inconsistent with aforesaid provisions as may be prescribed by the Company in the General Meeting by 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.

63. Without prejudice to the general powers conferred by the last preceding article and the other power conferred by these presents. It is expressly declared that the Directors shall

have the following powers provided that they shall follow section 196(2) of the Ordinance in exercising the powers enumerated therein.

a. To take on lease, purchase, erect or otherwise acquire for the Company any land, building, property, rights or privileges which the Company is authorized to acquire at such price and generally on such terms and conditions, as they think fit.

b. To sell, let, exchange or otherwise dispose of absolutely or conditionally all or any part of the property, privileges and undertaking of the Company upon such terms and conditions and for such consideration as they may think fit.

c. To buy, sell, import, export or procure the supply of all plants and machinery, material, stocks in trade and other movable and immovable property and things required for the purpose of the Company.

d. To engage, fix and pay the remuneration of and dismiss or discharge any manager, engineer, agent, secretary, clerk, accountant, workman, expert, technical adviser, or other persons employed or to be employed in or in connection with business of the Company.;

e. To appoint any person to be attorney of the Company for such purposes and with such powers, authority and discretions and for such period and subject to such conditions as they may from time to time think fit and to revoke such powers at pleasure.

f. To enter into, carry, rescind or vary all financial arrangements or agreement with any banks, persons or corporations for, or in connection with the Company's business and affairs and in connection with such arrangement to deposits, hypothecate any property of the Company or documents representing or relating to the same.

g. To take give receipts and other discharges for money payable to the Company and to the claims and demands of the Company and to draw, accept, endorse, negotiable promissory notes, bills of exchange or other negotiable and transferable instruments concerning/relating to business of the company.

h. To deal with surplus money of the Company not immediately required for the purpose thereof upon such terms and conditions as may be thought expedients.

i. To determine who shall be entitled to sign on Company's behalf, bills, cheques, notes, receipts, acceptances, endorsements, releases, contracts and documents.

j. To enter into such negotiations and contracts and rescind or vary all such contracts and execute and do all such acts, deeds and things in the name of the Company as they may consider expedient.

k. To open accounts with any bank or bankers and to pay into and withdraw money from such accounts from time to time.

l. To get insured the movable and immovable property of the Company.

m. To pay to any person employed by the Company a commission on the profits of the Company.

n. To institute, combat, prosecute, defend, compound, settle compromise, adjust, refer to arbitration, withdraw, abandon any legal proceedings by or against the Company or its officers or otherwise concerning the affairs of the Company.

o. To make advances for the business of the Company to such persons upon such security or without security as they may think fit, and generally to direct, manage, control the receipts, custody, employment, investment and expenditure of the moneys and funds of the Company and the keeping of accounts thereof.

p. To appear for and on behalf of the Company in any Court of Justice, Criminal, Civil or Revenue, Police, Postal, Excise, Transport, Income Tax, or other office in any action or proceedings or matters in which the Company may be interested and to promote, safeguard or defend its interest.

q. To sign and verify any plan, written statement, petition, compromise, mukhtarnama, vakalatnama, authorizing the legal practitioner to act on behalf of the Company in all Court, Civil, Criminal, and Revenue.

64. The Directors shall duly comply with the provisions of the Ordinance or any statutory modification thereof for the time being in force and in particular with the provisions in regard to the registration of the particulars of mortgage charges effecting the property of the Company or created by it, to the keeping of a register a summary of particulars relating thereto and notice of any consolidation or increase or decrease of share capital or sub-division of shares and copies of special resolution and a copy of the register of Directors and notifications of any changes therein.

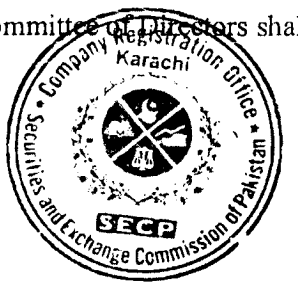
65. The Directors shall cause minutes to be made in books provided for the purpose;

a. of all appointment of officers made by the Directors;

b. of the names of the Directors present at each meeting of Directors and of any committee of the Directors;

c. of all resolutions and proceedings at all meetings of the Company and of the Directors and of committee or Directors.

d. and every Director present at any meeting of Directors or committee of Directors shall sign his name in a books kept for the purposes.



CHIEF EXECUTIVE

66. The Directors shall appoint any person including an elected Director to be a Chief Executive of the Company in the manner provided in Section 198 and 199 of the Ordinance.

67. The first Chief Executive appointed as aforesaid shall unless he earlier resigns or otherwise ceases to hold office, hold office up to the first annual general meeting of the company or, if a shorter period is fixed by the Directors at the time of his appointment, for such period.

68. The Company shall appoint a person who is not ineligible to become a Director of the Company under Section 187, the Chief Executive of the Company who shall hold office till the first Annual General Meeting.

69. The Directors of a Company by resolution passed by not less than three-fourth of the total number of Directors for the time being or the Company by a special resolution may remove a Chief Executive before the expiration of his term of office notwithstanding anything contained in the Articles or in any agreement between the Company and such Chief Executive.

BORROWINGS POWERS

70. Subject to the provisions of the Ordinance, the Chief Executive / Board of Directors shall have the powers to borrow any sums of money for and on behalf of the Company from commercial banks, or financing institutions including leasing, modarabas and other commercial institutions or the Directors may themselves advance money to the Company upon such terms and conditions as they may approve from time to time.

71. The Directors may from time to time secure the payment of such money in such manner and upon such terms and conditions in all respects as they may think fit and in particular by the issue of debentures or bonds of the Company or by mortgage or charge of all or any part of the property or assets of the Company.

PROCEEDINGS OF DIRECTORS

72. The Directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings, as they think fit. Questions arising at any meeting shall be decided by a majority of votes. In case of an equality of votes the Chairman shall have and exercise a second or casting vote. 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 a meeting of Directors to any Director for the time being absent from Pakistan.

73. The Directors may elect a Chairman of their meetings and determine the period for which he is to hold office; but, if no such Chairman is elected, or if at any meeting the Chairman

is not present within ten minutes after the time appointed for holding the same or is unwilling to act as Chairman, the Directors present may choose one of their member to be Chairman of the meeting.

74. The Directors may delegate any of their powers not required to be exercised in their meeting to committees consisting of such member or members of their body as they think fit; any committee so formed shall, in the exercise of the powers so delegated, conform to any restrictions that may be imposed on them by the Directors.

75. (1) A committee may elect a Chairman of its meetings; but, if no such Chairman is elected, of if at any meeting the Chairman is not present within ten minutes after the time appointed for holding the same or is unwilling to act as Chairman, the members present may choose one of their number to be Chairman of the meeting.

(2) A committee may meet and adjourn as it thinks proper. Questions arising at any meeting shall be determined by a majority of votes of the members present. In case of an equality of votes, the Chairman shall have and exercise a second or casting vote.

76. All acts done by any meeting of the Directors or of a committee of Directors or by any person acting as a Director, shall, notwithstanding that it be afterwards discovered that there was some defect in the appointment of any such Directors or persons acting as aforesaid, or that they or any of them were disqualified, be as valid as if every such person had been duly appointed and was qualified to be a Director.

77. A resolution in writing signed by all the Directors for the time being entitled to receive notice of a meeting of the Directors shall be as valid and effectual as if it had been passed at a meting of the Directors duly convened and held.

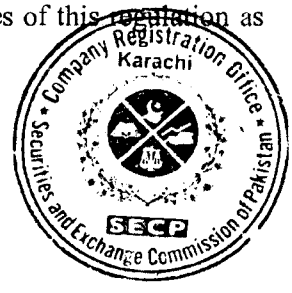
DIVIDENDS AND RESERVE

78. The Company in general meeting may declare dividends but no dividend shall exceed the amount recommended by the Directors.

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

80. No dividend shall be paid otherwise than out of profits of the year or any other undistributed profits.

81. Subject to the rights of persons (if any) entitled to shares with special rights as to dividends, all dividends shall be declared and paid according to the amounts paid on the shares, but if and so long as nothing is paid upon any of the shares in the Company, dividends may be declared and paid according to the amounts of the shares. No amount paid on a share in advance of calls shall be treated for the purposes of this regulation as paid on the share.



82. (1) The Directors may, before recommending any dividends, set aside out of the profits of the Company such sums as they think proper as a reserve or reserves which shall, at the discretion of the Directors, be applicable for meeting contingencies, or for equalizing dividends, or for any other purpose to which the profits of the Company may be properly applied, and pending such application may, at the like discretion, either be employed in the business of Company or be invested in such investments (other than shares of the Company) as the Directors may subject to the provisions of the Ordinance, from time to time think fit.

(2) The Directors may carry forward any profits which they may think prudent not to distribute, without setting them aside as a reserve.

83. If several persons are registered as joint-holders of any share, any one of them may give effectual receipt for any dividend payable on the share.

84. The dividend shall be paid within the period laid down in the Ordinance.

ACCOUNTS

85. The Directors shall cause to be kept proper books of accounts as required by section 230 of the Companies Ordinance with respect to:-

a. all sums of money received and expended by the Company and the matter in respect of which the receipts and expenditure take place;

b. all sales and purchases of goods by the Company;

c. all assets of the Company;

d. all liabilities of the Company;

e. all other matters required by the Authority from time to time;

86. The books of account shall be kept at the registered office or at such other place as the Directors shall think fit and shall be open for inspection during business hours.

87. The Directors shall from time to time determine whether and to what extent and at what time and places 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 members (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.

88. The Directors shall as required by Sections 233 and 236 cause to be prepared and to be laid before the Company in general meeting such profit and loss accounts or income and

expenditure accounts and balance sheets duly audited and reports as are referred to in those sections.

89. A balance sheet, profit and loss account, income and expenditure account and other reports referred to in regulation 74 shall be made out in every year and laid before the Company in the annual general meeting made up to a date not more than four months before such meeting, the balance sheet and profit and loss account or income and expenditure account shall be accompanied by a report of the auditors of the company and the report of Directors.

90. A copy of the balance sheet and profit and loss account or income and expenditure account and reports of Directors and auditors shall, at least twenty one days preceding the meeting, be sent to the persons entitled to receive notices of general meetings in the manner in which notices are to be given hereunder.

91. The Directors shall in all respect comply with the provisions of Sections 230 to 236.

92. Auditors shall be appointed and their duties regulated in accordance with Sections 252 to 255.

AUDIT

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

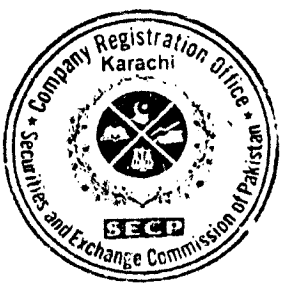
THE SEAL

94. The Company shall have a Common Seal and Directors shall provide for the safe custody thereof. The Seal shall not be affixed to any instrument except by the authority of a resolution of the Board of Directors and in the presence of at least two Directors and such Director shall sign every instrument to which the Seal is so affixed in his presence. Such signature shall be conclusive proof of the fact that the Seal has been properly affixed.

INDEMNITY

95. Every Officer or agent for the time being of the Company may be indemnified out of the assets of the Company against any proceedings, whether civil or criminal, arising out of his dealings, in relation to the affairs of the Company, except those brought by the Company against him, in which judgment is given in his favour or in which he is acquitted, or in connection with any application under section 488 of the Ordinance, in which relief is granted to him by the Court.

SECRECY



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

NOTICES

97. (1) A notice may be given by the Company to any member either personally or by sending it by post to him to his registered address or (if he has no registered address in Pakistan) to the address, if any, within Pakistan supplied by him to the Company for the giving of notices to him.

(2) Where a notice is sent by post, service of the notice shall be deemed to be effected by properly addressing, prepaying and posting a letter containing the notice 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.

98. If a member has no registered address in Pakistan, and has not supplied to the Company an address within Pakistan for the giving of notices to him, a notice addressed to him or to the shareholders generally and advertised in a newspaper circulating in the neighborhood of the registered office of the Company shall be deemed to be duly given to him on the day on which the advertisement appears.

ARBITRATION

99. Whenever any difference arises between the Company on the one hand and the members, their executors, administrator or assignee on the other hand touching the true intent or construction or the incident or consequence of these presents or of the statutes or touching any thing thereafter done, executed, omitted or suffered in pursuance of these presents or otherwise relating to these presents or to any statue affecting the Company, every such difference shall be referred for the decision of the arbitrator or umpire under the Arbitration Act, 1940 as amended from time to time.

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

WINDING UP

101. If the Company is wound up, the liquidator may with the sanction of 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.

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

Name and surname (Present & Former) in Block Letter. With full Address	Father/Husband Name in Full.	Nationality	Occupation	No. of Shares	Signature
ABDUL SATTAR KHAN HOUSE NO.GR/381,MUHALLA JHANGIR PADA HALI ROAD HYDERABAD CNIC No. 41304-6498907-7	ABDUL JABBAR KHAN	PAKISTANI	BUSINESS	90,000 (Ninety Thousand)	
SYED ZULFIQAR ALI SHAHEEN ARCADE FLAT NO.F-15. MUHALLA UNIT NO. 8, LATIFABAD HYDERABAD CNIC No. 42101-1007795-7	SYED IFTIKHAR ALI	PAKISTANI	BUSINESS	75,000 (Seventy five Thousand)	
DANISH HOUSE NO.113/C. MUHALLA UNIT NO. 10 LATIFABAD HYDERABAD CNIC NO. 41304-5337603-7	MUHAMMAD JAMEEL AHMED KHAN	PAKISTANI	BUSINESS	45,000 (Forty Five Thousand)	
UMER HASSAN QADRI HOUSE NO.149 BLOCK "E" MUHALLA UNIT NO. 6 LATIFABAD HYDERABAD CNIC No. 41304-2301797-9	SIDDIQUE HASSAN QADRI	PAKISTANI	BUSINESS	30,000 (Thirty Thousand)	
MUHMMAD ALI HASSAN HOUSE NO.149 BLOCK "E" MUHALLA UNIT NO. 6 LATIFABAD HYDERABAD. CNIC No. 41304-2288371-3	SIDDIQUE HASSAN QADRI	PAKISTANI	BUSINESS	30,000 (Thirty Thousand)	
MRS. MINAJ ALI HOUSE NO. 149 BLOCK "E" MUHALLA UNITNO. 6 LATIFABAD HYDERABAD. CNIC No. 41304-2223657-8	MUHMMAD ALI HASSAN	PAKISTANI	BUSINESS	15,000 (Fifteen Thousand)	
ADEEL AHMED KHAYYAM HOUSE NO.31/III/I MUHALLA 32 SABA AVENUE FAIZ DHA-EXT-V, KARACHI CNIC No. 41304-6784487-1	SHOUKAT KHAYYAM	PAKISTANI	BUSINESS	15,000 (Fifteen Thousand)	
			TOTAL	**300,000**	

Dated the 25th day of July 2014

Company Registration Office Karachi
Securities and Exchange Commission of Pakistan
SECP

Certified to be True Copy
25/8/14
Joint Registrar of Companies

Witness to above signatures.
Full name: ZEESHAN AMBER
NIC N/o 41304-3783349-3
Father/ Husband name MUHAMMAD BASHIR SIDDIQUI NIHAL
Full Address HOUSE No: 17MUHALLAH NEAR GAZALI COLLEDGE UNIT No: 11
LATIFABAD HYDERABAD.
Occupation Private Service

Serial No.....
Name of the Company.....
Brief Description of the document including its enclosures.....
Then date on which the document is registered filed or reconed....

Joint Registrar of Companies
Companies Registration Office
Karachi.

HYTEX ENERGY (PVT) LTD.

REGISTERED OFFICE	PLOT No. B-5, S.I.T.E, HYDERABAD.
PLANT LOCATION	PLOT No. B-5, S.I.T.E, HYDERABAD.
TYPE OF FACILITY	TEXTILE WITH CAPTIVE POWER PLANT.

PLANT CONFIGURATION

PLANT SIZE	5 MW (1.5 MW + 3.5 MW)
DE RATED CAPACITY (85%)	4,250 KW
PARASITIC LOAD	500 KW
IN HOUSE CONSUMPTION	750 KW
LOAD AVAILABLE FOR HESCO	3,000 KW
TYPE OF TECHNOLOGY	STEAM TURBINES
NUMBER OF GENERATORS	02 SET
CAPACITY OF EACH GENERATOR	5 MW (1.5 MW + 3.5 MW)
MAKE AND MODEL	SHINKO JAPAN
GROSS CAPACITY	5 MW
DATE OF COMMISSIONING	1.5 MW October 2014 3.5 MW Installation in progress

FUEL USE

FUEL TYPE	BIO MASS / COAL
FUEL (IMPORTED / INDIGENOUS)	LOCAL
FUEL SUPPLY (Bio Mass) (Coal)	D.B CHANDIO & ASSOCIATES LALA DHANI BUX COAL AGENT

WATER

COOLING WATER SOURCE	GROUND WATER

HYTEX ENERGY (PVT) LTD.

EXPECTED REMAINGING LIFE OF THE FACILITY	10 YEARS

PLANT CHARACTERISTICS

GENERATION VOLTAGE	11,000 VOLTS
FREQUENCY	50 HZ
POWER FACTOR	0.80 LAGGING
AUTOMATIC VOLTAGE REGULATORS	PROVIED
RAMP TIME ADJUSTMENT	PROVIED (15-20 SECONDS)
METERING POINT	The metering arrangement will be installed, as per specifications of HESCO in a separate room at interconnection point.
METERING SYSTEM	All meters and metering devices Available at the Metering Room of the Generation facility can be used for Recording of energy to be supplied to HESCO. The accuracy class of meters will be +/- 0.5.
CONTROL AND INSTRUMENTATIONS	All control and instrumentation are provided to ensure safety according to the Prudent Electrical Practices.

HYTEX ENERGY (PVT) LTD.

Steam Boiler Technical Data (Reconditioned as original refurbished)

Type	Water tube D type
Total Designed Capacity	45 TPH on Bio mass/Coal
Boiler 1	**15 tone per hour**
Working Pressure & Temp	25 Bar at 350 Deg. Centigrade
Boiler 2	**30 tone per hour**
Working Pressure & Temp	45 Bar at 350 Deg. Centigrade
Efficiency & generation	85 %
Fuel	Bio Mass / Coal lumps 10 mm + - 5 %
Solid fuels	25 mm dry

Mounting and Fittings.

Main stop valve

Safety valve

Water Level with automatic control

Water level cock set

Air vent

Pressure gauge of adequate size with siphon and valve

Feed Check valve

Blow Down Valve

Steam pressure controllers with Siphon & valves

Feed water pump

Travel chain grate with hopper

HYTEX ENERGY (PVT) LTD.

(Nonstick, Designed on Pakistani coal)

- Blast fan (FD Fan) for Chain Grate air feeding,
- Fuel feeding hoisting machine
- Ash collection screw conveyor
- Speed control for chain grate
- Ash collector multi cyclone
- ID fan with motor
- Air pre heater
- PLC Electric control panel
- Economizer
- Deaerator
- Refractory

Dry run before heating & pre commissioning, Feed water tank, blow down tank, steam header & related piping.
Insulation works of tanks & piping. Inter-connecting piping.

Steam header with Valves & condensate assembly, frame mounted with insulation and cladding.

Feed water deaerator tank with valves, level glass with insulation and cladding.

R. O. plant with piping, valves and controls.

Blow down tank, vertical, dish top with sound less three stage designs.

Condensate Pump with Valves assembly.

All boiler house interconnecting piping, fittings, valves, controls (Steam, Drains, Condensate ASSEMBLY, Blow Down Feed water, Level Glass etc.

Boiler house insulation with cladding. (50 mm Rock wool with 26g GI Sheet)

HYTEX ENERGY (PVT) LTD.

Steam Turbine

Power:	5 MW (1.5 MW + 3.5 MW)
Type:	Multistage/Condensing with option of Extraction
Inlet pressure:	25 Bar & 45 Bar Respectively
Inlet temp.	350 ^{o}C.
Final RPM:	1500
Governor:	UG-40 Woodward
Make:	SHINKO JAPAN
Alternator:	Cummins UK
Voltage	11000 V
Power:	1800 kVA + 4200 kVA
RPM:	1500
Frequency:	50 Hz.
Power factor:	0.8
Type:	Air cooled
Service:	Continuous
Excitation:	Brushless

Complete with all accessories, SS Tubes Condenser with complete automation, Turbine and Generator control panel.

HYTEX ENERGY (PVT) LTD.

Steam Turbine Assembly

Gear Assembly

Alternator Assembly

Alternator cooling system

Exciter Assembly

Turbine Governor Assembly

Combined Stop & Emergency Valves Assembly

Main Oil Pump Assembly

Lubricating Oil Tank Assembly

Duplex Oil Filter Assembly

Oil Cooler

Interconnecting Oil Lines, valves, hangers, etc.

Interconnecting Cooling Water Lines, valves, hangers, etc.

Turbine Indicator Panel

Drain Lines, valves, hangers, etc.

Turbine & Generator Control Panels

Condenser

SS Tubes Condenser with accessories

Turbine house accessories

Turbine house

Cooling tower pumps, valves & piping

Steam line boiler to steam turbine max 100 FT

Condensate line steam turbine to boiler 100 FT

Electric wire control panel to turbine control.

Condenser, pumps & piping attachment.

HYTEX ENERGY (PVT) LTD.

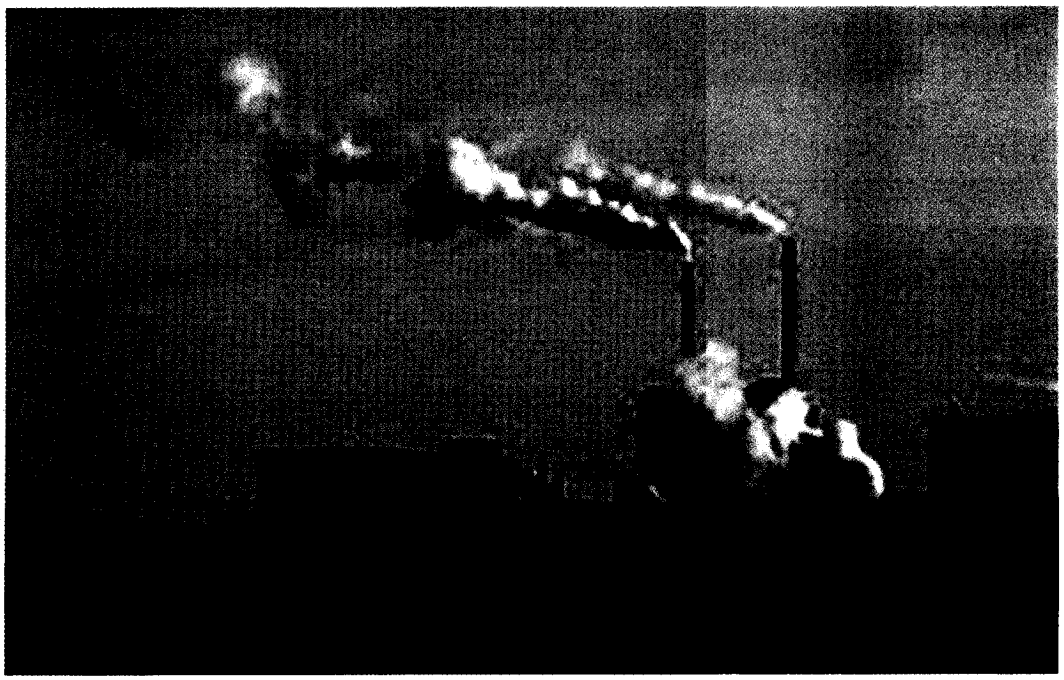
5 MW COAL FIRED POWER PLANT

Power Plant Installed Capacity	5 MW (1.5 MW + 3.5 MW)
Efficiency	85 %
Net Output	4250 KW
Parasitic Load	500 KW
In House Consumption	750 KW
Net Output for Sale	3000 KW
Fuel	Bio Mass / Coal
Indigenous	Local

HYTEX ENERGY (Pvt.) Ltd.

DRAFT FEASIBILITY REPORT

5 MW COAL FIRED POWER PLANT HYDERABAD



Consultant:-

Electrovission Engineering & Services
161 – B, Unit No 7/D Latifabad, Hyderabad.

H Y T E X ENERGY (PVT) LTD.

5MW Coal Fired Power Plant

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INTRODUCTION

1.1 GENERAL

In 1980s acute power shortage was experienced in the country resulting in long load shedding, causing tremendous adverse impact on the economy. In order to alleviate this energy crisis, Government of Pakistan 'created Private Power cell under the ministry of Water And Power Government of Pakistan which was subsequently upgraded as Private Power and infrastructure Board (PPIB) to encourage and facilitate the private sector for investing in power generation. PPIB announced Power Policy in 1994 under which a number of thermal power projects were setup, mostly based on imported furnace oil. These power plants greatly improved the power availability in the country, but import of oil caused heavy burden on national economy. In order to reduce dependence on imported fuel, a number of private power plants and some of the WAPDA'S plants were subsequently converted on natural gas.

In 1998, Government of Pakistan reframed power policy. According to this policy three (3) Generation Companies (GENCOs) were setup in Thermal Power Wing of WAPDA with a view to ultimately privatize existing Public Sector owned thermal power plants. Subsequently the Fourth Generation Company (GENCO-4) comprising 3x50 MW coal fired power plant at Lakhra was also created in public sector. Furthermore thermal power generation was restricted to the private sector only. However, the response of private investors was not very enthusiastic and therefore, GOP felt necessary to create an environment with new incentives attracting the private investor on one hand and to keep electricity prices within affordable limits for consumers on the other hand. As such, Power Generation Policy of 2002 has been introduced emphasizing the use of indigenous fuel resources. PPIB is striving hard to boost up power generation by inviting prospective investors and imparting them necessary guidance and support for the development of hydel as well as thermal power projects, In 2002 policy for power generations the following financial incentives have been offered.

a) Permission for power generation companies to issue corporate registered bonds,

b) Permission to issue shares at discount prices to enable venture capitalists to be provided higher rates of return proportionate to the risk.

c) Permission for foreign banks to underwrite the issue of shares and bonds by the private power companies to the extent allowed under the laws of Pakistan.

d) Abolition of 5% limit on investment of equity in associated undertakings.

e) No levy of sales tax on such plant, machinery and equipment, as the same will be used in production of taxable electricity.

f) Exemption is already available from income tax including turnover rate tax and withholding tax on imports; provided that no exemption of income tax on oil-fired power plants.

g) Repatriation of equity along with dividends is freely allowed, subject to the prescribed rules and regulations.

h) Parties may raise local and foreign finance in accordance with regulation applicable to industry in general. GOP approval may be required in accordance with such regulations.

i) Maximum indigenization shall be prompted in accordance with GOP policy.

According to load forecast study conducted by WAPDA'S Power Planning Department, load demand in the year 2024~25 will rise to the tune of 41,909 MW considering high growth scenario and 29,623 MW in case of low growth scenario, predicting rise in growth rate from 4.2% to 7.5% by the year 2024-25. The above study indicates that unless speedy measures are adopted for setting up new power generation projects, load shedding which has alreaoy commenced from the year 2013-14, will further aggravate in the following years.

1.2 SIGNIFICANCE OF COAL FIRED POWER PLANTS

The conventional methods of electric power generation are based on utilization of petroleum products like Heavy Fuel Oil, Natural Gas and High Speed Diesel Oil etc,

Non-conventional methods include Nuclear Power plant, Renewable Energy Power Plants and Biomass Power Plants.

A comparison of coal fired power plants with non-conventional power plant will be meaningless for the purpose of this study.

For conventional power plants due to sky rocketing prices of petroleum products the fuel cost component of the Power Tariff accounts for nearly 70% of the total tariff. It is therefore of vital importance that options of cheaper fuels (per million Btu basis) are adopted for power generation.

A comparison fuel prices on per million Btu for serious fuels based on today prices is as under.

Sr. No.	Fuel	Heating Value (HHV)	Market Price	Cost/ MMBtu	Ratio	Ranking
1.	Coal	12100 Btu/kg 5500 Btu/lb.	Rs. 2000/T	Rs. 165.29/ MMBtu	1.0	I
2.	Natural Gas	930 Btu/scf.	Rs. 272/ MMBtu	Rs. 272/ MMBtu	1.65	II
3.	HFO	40200 Btu/kg	38000 / Ton	Rs. 945.27 / MMBtu	5.73	IV
4.	HSD	19000 Btu/lb 41800 Btu/kg	Rs. 45.05/ liter Rs. 53.05/KG	Rs. 1267.94 / MMBtu	7.68	V
5.	LPG	47000 Btu/kg	Rs. 40000/ Ton Rs. 34000/ Ton Excluding Sales tax	Rs. 723/ MMBtu	4.38	III

It is therefore evident from the above that utilization of coal for power generation is the most favorable option. Natural gas is the second best option, however, it is a commodity which is In short supply and its further utilization for power generation has been restricted.

The share of coal based electric power generation in the world is in excess of 40%. Some of the advanced countries like UK have series of large (600 MW and above) power plants based on coal.

Enormous coal reserves in Pakistan which is a blessing for the country need to be utilized for power generation. In Bharat coal of the same quality as Hyderabad coal is being transported up to 1500 km for power generation. Pakistan must concentrate on development of power plants based on coal.

1.2.1. Pakistan Coal Reserves

Pakistan has been blessed with large resources of coal spread over all the provinces in the country. Total coal reserves in the country have been estimated at 185.175 billion tons. Province wise details of these reserves are as under.

Province	Coal Reserves	Heating Value
Coal Field	**Million Tones**	**Btu/lb**
SINDH		
Thar	175,506	6244-11045
Lakhra	1,328	5503-9158
Sonda – Jhimpur	5,523	5219-13555

Province	Coal Reserves	Heating Value
Meting- Jhimpur	473	**5219-8612**
Indus East	1,777	7782-8660
Badin	16	11415-11512
TOTAL	**184,623**	
BALOCHISTAN		
Sor-Range/ Degari	50	11245-13900
Khost-Sharigh-Harnai-Ziarat	88	9637-15499
Mach	23	11110-12937
Duki	56	10131-14357
TOTAL	**217**	
PUNJAB		
Salt Ranges	213	9472-15801
Makarwal	22	10688-14029
NWFP		
Hangu	82	10500-14149
Cherat	9	9386-14217
TOTAL	**91**	
AZAD KASHMIR		
Kotli	9	7336-12338
GRAND TOTAL	**185,175**	

1.2.2 Sindh Coal Reserves

The total coal resources of the Province of Sindh have been estimated at 184.6 billion tons. The major coal field are Thar, Lakhra, Sonda, Jherruck and Indus East and Badin. The location of these coal field is given in attached map.

The estimated reserves of each field are as under:

Location	Coal (Million Tones)
Thar	175,506
Lakhra	1,328
Sonda- Jhimpur	5,523
Meting- Jhimpur	473
Indus East	1,777
Badin	16
Total	**184,623**

1.2.3 Quality of Coal

The coal reserves and chemical analysis of coal samples for the coal from various Coal Mines of Sindh is as under:

THAR COAL QUALITY & RESERVES

Coal Quality	
Moisture (%)	29.60 – 50.50
Ash content (%)	02.90 – 11.50
Volatile Matter (%)	23.10 – 36.60
Fixed Carbon (%)	14.20 – 34.00
Sulfur (%)	00.40 – 02.90
Heating Value (Btu/lb)	
As received	6,244 – 11,045
Dry Basis	10,723 – 11,353
The quality of coal is Lignite-B to Lignite-A	
Coal Reserves (Million Tones)	
Measured	2,7000
Indicated	9,395
Inferred	50,706
Hypothetical	112,705
Total	175,506

LAKHRA COAL QUALITY & RESERVES

Coal Quality	
Moisture (%)	09.70 – 38.10
Ash content (%)	04.30 – 49.00
Volatile Matter (%)	18.30 – 38.60
Fixed Carbon (%)	09.80 – 38.20
Sulfur (%)	01.20 – 14.80
Calorific Value (Btu/lb)	5,503 – 9,158
The quality of coal is Lignite-A.	
Coal Reserves (Million Tones)	
Measured	244
Indicated	629
Inferred	455
Total	**1,328**

SONDA-JHERRUCK COAL QUALITY & RESERVES

Coal Quality	
Moisture (%)	09.00 – 48.00
Ash (%)	02.70 – 52.00
Volatile Matter (%)	16.10 – 44.20
Fixed Carbon (%)	08.90 – 58.80
Sulfur (%)	00.20 – 15.00
Calorific Value (Btu/lb)	5,219 – 13,555
The quality of coal is Lignite-A.	
Coal Reserves (Million Tones)	
Measured	245
Indicated	1,611
Inferred	5,917
Total	**7,773**

1.2.4 Lakhra Coal Field

Lakhra Coal Field is fully developed and contains mineable coal reserves of 146 Million Tons. Sindh Coal is classified as Lignite with calorific value ranging from 5219 to 13555 Btu/lb.

Feasibility Studies carried out by various agencies including john T boyd of USA have confirmed mineability and suitability of coal mining from this area. Lakhra Coal contains high sulfur and high ash.

Various studies carried out be national and international organization including the following:

- WPIDC
- GSP
- JICA
- John T Boyd
- USGS

All the above organizations have confirmed that Lakhra Coal is suitable for power generation, Lakhra coal being an indigenous fuel is most suitable for generation of power at cheap rates. Power generation from Lakhra coal will reduce the burden on foreign exchange which is already short in the country.

1.3 WASHING HIGH ASH COAL

1.3.1 Objectives

The overall objective of the study is to demonstrate and evaluate the technical and economic feasibility of producing low ash coal for 51 MW Coal Fired Hyderabad Power Plant with the possibility of recovering heat lost in the coal washing plant waste by combustion in a slave fluidized bed based power plant.

1.3.2 Historical Applications

Pakistan does not possess sufficient experience on the use of coal for power generation and much less for coal washing, The study for feasibility of coal washing has to be based on the experience of the countries who possess sufficient knowledge in the field.

India is the third largest coal producer in the world with production of about 500 million tons annually out of which about 250 million tons annually is used for power generation.

The quality of run-of- the mine coal in India currently contains about 42% of ash. The Government of India has recently introduced regulation to reduce the ash content of coal from 42% to 34% required to be transported over long distances to the power generating plants. This is the primarily to reduce burden on rail capacity, energy and cost as well as pollution. The mining and power companies have resisted these regulations since the reduction in cost of transportation does not adequately compensate for the additional cost of coal washing. The cost of reduction of transport needs to be greater and the ash content of the washed coal has to be lower in order to make the coal washing process feasible.

The reduction in ash content of the washed coal increases the energy loss as some combustible coal is also lost in the washing process. Generally 5-8% of the energy is lost in the washed coal. As the content of ash in the coal is reduced before feeding to the boiler, the efficiency of the boiler is increased.

The Indian experience is that coal washing with reduction in the ash content from 42% to 28% is feasible for adequate cost reduction in transportation in excess of 500 km transportation of coal. Coal with 42% ash content does not cause problems in the modern FBC and CFBC boiler.

The cost of the coal washing is considered high and benefits from a discard fuelled power station are too low.

1.3.3 Coal Washing

There are two systems for coal washing in use around the world which are briefly described here under:

- **Water Based System**

The two systems that have been considered are the jig and the barrel systems. Both systems are available and used worldwide.

A jig consists of a U-tube containing water. The water is made to rise and fall through a perforated plate, effecting a separating of less dense material, that floats to the top and more dense material that sinks to the bottom. Jigs are manufactured that have a capacity of up to 1,000 tph. They are constricted by their capacity to extract discard and changes in raw coal quality effect the separation.

A barrel comprises a tube fitted internally with a scroll. The barrel rotates about its long axis and is mounted at an angle of about 5° to the horizontal and coal introduced at the top end along with water. The water washes the coal to the bottom of the barrel, while the scroll moves the denser discard to top end where it is discharged. Barrels are manufactured with a capacity of up to 200 tph. Although smaller than a jig, the low cost of manufacture ensures that moderate throughput can be obtained at relatively low cost. The barrel is also very simple to operate and several have already been installed in the World. Of the two water-based systems modeled only the jig permitted cleaning at 8 mm lower size.

- **Magnetite Based System**

Dense medium systems rely on the less dense coal floating on a liquid with a higher density than itself, but not so high that the more dense shale will float. The liquid is formed from a suspension of finely ground magnetite in water.

The dense medium batlp can separate coal with a size of more than 6mm. below this size, the separation deteriorates rapidly. Dense medium baths can be manufactured with capacity up to 350 tph.

DESCRIPTION OF THE POWER PLANT EQUIPMENT

8.1 GENERAL

Brief description of the major power plant equipment is given as below:

- 15 tph Steam Boiler equipped with Chain Grate
  reheat steam boiler; open boiler house except for burner feeder area and tripper belt gallery consisting of coal conveyor system over the coal bunkers.
- Sub critical, tandem compound, condensing, with one steam reheat turbine having seven stages of steam extraction for feed water heating. The turbine will directly drive alternating-current generator with static excitation system, Enclosed turbine generator building with overhead cranes, feed pumps etc.
- Electrostatic precipitators in double row arranged on ground-level between the air pre-heater and the stack.
- A chimney stack of M. S. Sheet,
  discharge tube. The top part of five meters made of high corrosion-resistant steel.
- Coal storage and handling system.
- Limestone storage and feeding system.
- Ash removal system for furnace bottom and precipitator with pneumatic pressure system for dry precipitator fly ash.
- Offsite ash disposal landfill.
- Closed cycle cooling water system with mechanical draft Fiber cooling towers and vertical pumps in circulating water pump house.
- Makeup water intake system through Over Head Tank and Under Ground Tank through centrifugal Pumps.
- Stand by Diesel generator for emergency power only. (No black start capability).
- Data acquisition, logging, control and monitoring through DCS.
- 11 KV switch yard with adequate numbers of circuit breakers and auxiliary equipment.
- Balance of plants and auxiliary equipment.
- 11 KV/440 V step Down Power transformers, startup and auxiliary transformers.
- Economizer
- Air Preheater
- Supper Heater
- Multi Cyclone
- Deareater

STEAM GENERATOR AND ANCILLARIES

The boiler unit is proposed to be a double-drum, equipped with chain grate.

- In convection zone where heat is removed from the flue gas by superheater, reheater, economiser and air preheaters.

The composition fuel is given earlier in Chapter - 1 (Introduction) and of sorbent i.e. limestone available in the vicinity of power plant is given below:

Constituent's	**Chemical composition**
Silicon	8.75
Alumina	1.40
Iron Oxide	0.90
Calcium Oxide	46.59
Magnesium Oxide	2.53
Sodium Oxide	0.22
Potassium Oxide	0.05
Loss on Ignition	38.78

Boiler Furnace:

Boiler height can vary depending upon design with or without internal recycle, but will be in the range of 30 to 35 m. The residence time for air and combustion gas is accordingly between 6 and 7 sec.

Boiler has to be designed preferably with no heat exchange surfaces in the bed. Further the furnace wall tubes will be selected with a minimum wall thickness much exceeding the code requirement to withstand metal wastage.

The furnace enclosure will be made of gas-tight membrane.

The furnace primary zone will be reduced in plan area cross section to provide good mixing and promote solids entrainment at low load. The in duct startup burners, fuel feed points and secondary ash re-injection (from Multicyclone Dust Collectors / MDC) points will be located in this region.

A thin layer of refractory will be applied on all lower furnace walls, including the lower portion of the division walls and wing wall nose to protect against corrosion and erosion.

An ultra-high strength abrasion-resistant low cement alumina refractory 15- 25 mm thick may be applied over a dense pin studded pattern. The furnace temperature will be precisely controlled by maintaining proper coal feed and thus the combustion efficiency and the limestone utilization are maximized,

Secondary Solids Separator

The multi-cyclone dust collector (MDC) will be located in the convection zone downstream of the economizer. The MDC typically has a top inlet and top outlet. The MDC tube diameter will normally be equal to or more than 229 mm arranged over the second pass entire cross section. The MDC will provide retainment of fine particles up to 50 microns. The MDC collection tubes and spin vanes will have high hardness (550 BHN), designed for longer life and easy replacement during planned outages.

The small quantities of fines which escape from the external U-Beams will be collected by the MDC. The collected fines are stored in the MDC hopper. Variable speed rotary feeders or inclined screws will be used to control the ash recycle flow rate from the hopper. Precise furnace temperature control will be achieved by adjusting the speed of the rotary feeders or inclined screws, taking the temperature signal from the furnace.

Pendant Type Super heater / Reheater

The super heater will consist of vertical pendant type primary and secondary banks, located in the convection pass, as well as surface in the furnace in the form of super heater wing walls.

An attemperator will be used to control the final steam temperature over the design load range. The flue gas velocities will be relatively low and selected by considering the dust loading and ash erosivity of the fuel.

The reheater will be located in the convection pass, and steam bypass will be installed to control the final reheater temperature.

Economizer and Horizontal Tubular Air Heater

The economizer will be designed with tubes running front to back in an in- line arrangement. Flue gas velocities used consider the dust loading and ash erosivity of the fuel.

The air heater will be located after the MDC and the economizer.

The flue gas will be outside the tubes and air will pass through the tubes. A hopper will be provided at the bottom of the air heater and the ash collected in the hopper will be purged to the ash disposal system. The tube material and flue gas velocities other than recommended earlier will be selected by manufacturer after carefully considering the dust loading and the ash erosivity of the fuel. A steam coil air heater (SCAH) will also be used to protect the cold end corrosion of the air heater if required.

Air-Assisted Gravity Fuel Limestone Feed System

The crushed fuel (6-10 mm) will be stored in two bunkers, located in front of the boiler as shown in Figure 8.1 and elevation Drawing No.8.2.

Fuel will be fed to the boiler via down spout from bunker discharge to four of feeders and gravity feed chutes. The fuel chute will have at least a 65 degree angle from horizontal. Primary air will be used to sweep the fuel into the furnace and as

seal air to the feeders. The number of feed points has been set to achieve even fuel distribution in the furnace.

The limestone handling and feeding system will be relatively simple compared to the fuel feed system. Limestone will be fed either pneumatically or mechanically into the boiler. The pneumatic system feeds the limestone directly into the furnace through furnace openings in the front wall. In the mechanical system, the limestone will be fed into the discharge end of the fuel feeders via rotary feeders.

The limestone falls by gravity down the fuel feed chute with the fuel into the furnace, and will be a function of fuel velocity and required emissions.

A chemical injection package consisting of facilities to feed and control appropriate quantities of oxygen scavengers, scale and corrosion inhibitors, and filming and neutralizing agents to the appropriate locations within the boiler feed water system will be provided.

Safety Valves

An impulse safety system will be installed on the main steam line. The design capacity of a single impulse-safety system will be 15 & 30 tph at steam parameters of 25 Kg 350 ^{o}C and 45 Kg 350 ^{o}C.

Altogether, there will be four impulse-safety systems. Two of these will operate by an impulse indicating the pressure in the boiler drum and the other two on an impulse indicating the pressure in the steam collecting header of the superheater.

The main components of the impulse-safety system will be:

A main safety valve: an impulse valve with an electromagnetic drive and a filter; an electro-contact pressure gauge.

Pressure rise in the drum or in the steam collecting header above the nominal level will lead to actuation of the electro-contact pressure gauge, which will be tuned to a certain pressure rise. The electro-contact drive of the impulse valve will be activated. The force of the electromagnet added to the force of the static steam pressure on the plate of the impulse valve ensure opening of the latter.

The steam from the impulse valve flows through a connecting tube and enters a piston chamber of the main safety valve. The force, developed by a difference in the piston areas, opens the main safety valve releasing the steam into the environment.

The valves are proposed to be designed to blow at a pressure ot 1.05 times of the working pressure (for the auxiliary valves), and at 1.08 of the working pressure (for the main valves).

Upon the pressure drop to the nominal level, the electro-contact pressure gauge change over the circuits of the electromagnets, thereby closing the impulse valve.

Access of steam into the piston chamber of the main safety valve will be blocked and the main safety valve closes.

On voltage failure, the impulse valve will be actuated by a load system duly tuned in advance to independent operation.

Draft Plant

Each boiler will have two axial included draft (ID) fans and two centrifugal forced draft (FD) fans of appropriate size. The air of FD fans will be distributed into two systems, one for bottom nozzles and other to enter from front and rare walls at relatively higher speeds. The gas and air ducting will be so arranged as to ensure, when necessary, unit operation with one set of ID/ FD fan will cover 60 % boiler load. FD fans may be kept at double speed during this operation. To service I.D. and F.D. fans, provision will be made for a gantry crane and metal works of crane trestle.

STEAM TURBINE

The turbine is proposed to be steam condensing tandem compounded impulse; throttle controlled three cylinder machine without controlled steam extractions with one steam reheat.

Steam reheating will be affected between high pressure cylinder and medium-pressure cylinder.

The low pressure cylinder will be of double-pass construction with three stages in each pass.

Summary Description and design

Steam turbine will be single-shaft three cylinder set, the high pressure cylinder will have one control stage and rotor will be integral-forged construction.

The intermediate-pressure rotor will have mostly forged integral disks and partly fitted on disks. Live steam from boiler will be admitted through two pipelines to two separately standing steam chests housing automatic stop valves in it. On leaving steam chests, steam will be delivered into four steam chests of the governing valves welded into front part of high-pressure cylinder.

After passing the high-pressure cylinder, the steam will be directed to reheater and then it will return back to turbine through stop and governing valves of intermediate- pressure cylinder (Drawing No. 8.3).

From the intermediate-pressure cylinder the steam will be conveyed by two crossover pipes to the middle part of low-pressure cylinder where it will fork into two streams, on passing its own half of the cylinder, will enter into one half of condenser.

Both halve of condenser will be welded to the exhaust connections of cylinder. The turbine will have seven bleeds (uncontrolled steam extractions) which are needed for feed water heating in the low-pressure heaters, in the deaerator and in the high pressure heaters.

The protections shall conform to the applicable safety standards. Under stable conditions vibration at nominal speed on turbine pedestals shall be in accordance with permitted values as per international standard ISO 10816-2 or equivalent. The turbine shall operate under all operating condition without significant vibrations and noise. The noise of TG set shall not exceed 85 dB (A) measured at a distance of 1 meter from TG Set,

The turbine's oil system will be designed to feed a special grade of a turbine oil to both the governing system: at 20 kg/cm^2 and the lube oil system of the turbine and generator bearings at 1.0 kg/cm^2 downstream of the oil coolers as measured at the level of the turbine center line.

The oil will be fed into the governing system by a centrifugal pump driven directed by the turbine shaft. The lube oil will be fed into the system (before the oil coolers) by means of two injectors connected in series. The first of the injectors will also be designed to ensure the required head at the suction of the centrifugal pump belonging to the governing system about 1 kg/cm^2.

For turbine servicing during startup periods there will be a motor driven starting oil pump. The pump will be selected to suit the purposes of hydraulic testing of the oil pipework in the governing system by double working pressure, performed before the turbine is started and during inspections.

The turbine will be provided with a stand by motor driven lube oil pump. The output pressure of this pump will be 30 m WG. There will also be an emergency lube oil pump. Its output head will be 23 m WG. The pump will be driven by a DC electric motor.

An oil pressure drop relay will automatically start the electric motor of the stand-by pump and will simultaneously send a warning signal when the pressure drops to the 15' limit. If the pressure continues to decline and reaches the 2" limit, the relay will start the electric motor of the emergency oil pump running on direct current. Should the pressure drop to the 3" limit, the relay will trip the turbine and the motor of the barring gear.

A welded oil tank will be provided with an oil level indicator which has contacts to send light signals indicating the minimum and maximum oil level in the tank.

Filters will be mounted in the oil tank for cleaning oil from mechanical impurities. The design of the oil tank should be such that the filters can be changed quickly and safely while the turbine is in operation. For oil cooling purposes, provisions will be made to have four surface oil coolers. On the water and oil sides, the coolers will be connected in parallel. Provisions will be made to cut off any of the coolers on the water side and on the oil side for cleaning purposes, even if the turbine is carrying full load and the cooling water temperature does not exceed 36 °C.

Summary Description and design

The- major components of the main and reheat steam system are the steam generator (superheaters, reheater, and attemperators), main and reheat steam piping, and the main turbine (HP, IP and LP).

The main steam pipes leading to the HP turbine stop valves are provided with warm-up and drain connections. The warm-up drain piping ("Turbine bypass") will be manifolded into a single pipe with a motor operated valve. This motor operated valve will be controlled through PLC. The valve will be open during hot and warm starts until steam temperature is raised to within the acceptable range of turbine metal temperature.

The warm-up drains are passed through an on-off desuperheater before entering the condenser through a loop seal. The desuperheater spray, from the condensate system, will be actuated when the motor operated warm-up valve starts to open.

Superheated steam temperature will be controlled by use of coal feed and desuperheating sprays. Final superheat temperature will be automatically maintained at set point by the controlled ratio of fuel to teed water over the load range. As an overriding control feature for interim changes of steam flow or final steam temperature, spray water will be used to maintain a constant steam temperature at the outlet.

The boiler reheat outlet steam temperature will be controlled by the combustion control system. De-superheating spray water from the boiler feed pumps bleed point will be sequenced into the control for automatic operation on an emergency basis only.

The exhaust from the HP turbine (cold reheat) will be returned to the boiler for reheating though two cold reheat lines. The cold reheat piping will be sized for a pressure drop equal to 2 percent of the high pressure exhaust pressure, permitting 3 percent of HP exhaust pressure as the allowable drop in the hot reheat piping and 5 percent of HP exhaust pressure for the boiler reheater pressure drop. On the connecting pipe between the cold reheat circuit are safety valves to protect the system from overpressure.

Steam from the interconnection of cold reheat piping will be supplied to HP heater 2 and station auxiliaries pressure reducing and desuperheating plant.

Desuperheating spray water for the reheat desuperheaters will be either from the boiler feed pump's inter-stage bleed or from the steam coolers.

The hot reheat system combines the piping at the boiler outlet into two alloy steel pipes leading to the IP turbine control valves.

The turbine bypass will be sized for 30 percent of the main steam throttle flow. The bypass flow will go to the condenser after pressure and temperature reduction. This bypass arrangement will improve the turbine start-up times as well as overall boiler warm-up time.

The turbine will have a motor driven barring gear which will rotate the turbine's rotor at a speed of about 3-4 rpm. Provisions will be made for remote starting of the barring gear from the control board. Besides, the turbine will have a device for periodical turning (every 10 minutes) of the shaft over 180 °C

BOILER FEED WATER SYSTEM

The Boiler Feed water System for each unit will be designed to pump feed water from the deaerator storage tank, through three stages of high pressure feed water heating, to the economizer inlet of the steam generator. During all modes of operation, the feed water system provides heated water required to satisfy the boiler steaming requirements.

The major components of the boiler feed water system for each unit are three half capacity motor driven main boiler feed water pumps, and three full size high pressure feed water heaters.

Summary Description of the system and design

The boiler feed pump suction from the deaerator storage tank to each pump will be through individual pipes. The suction piping includes an isolation valve (motor operated) and a permanent, single basket strainer.

The suction isolation valves include limit switches which are interlocked with the associated booster pump motor to prevent starting the pump when the valve is not in the 'Open' position. Tripping will occur on motor overload, low lube oil pressure, or suction valve not fully open. Starting permissive are sufficient lube oil pressure, recirculation valve "Open", and suction valve "Full Open", when operating with one feed pump, tripping automatically starts the standby pump.

Alarms in the main control room annunciate on low lube oil pressure, high vibration, and high bearing metal temperature on either pump or motor bearings.

Feed pump recirculation will be controlled by a flow (Differential Pressure, DP) switch across an orifice located in the discharge of each pump. This flow signal controls an on-off recirculation valve for each pump, returning flow to the deaerator.

The recirculation lines are connected to the pump discharge ahead of any valves.

The discharge of each main feed water pump flows through a balanced type tilting disc check valve and a motor-operated wye-pattern stop check valve to a common discharge line.

The superheat desuperheating -and bypass system desuperheating spray water will be taken off the boiler feed pump discharge upstream of the first high pressure heater. Reheat desuperheating spray water will be taken from an interstage bleed on the main feed water pumps.

Main feed pump warm up will be accomplished by bypassing the pump suction isolation valve, bleeding deaerator water through the pump, and dumping to the condenser through a self-regulating back pressure control valve. The feed water booster pump suction valve will be opened for warm-up.

Main feed water pump recirculation will be controlled by a flow (DP) switch across an orifice located in the suction of each pump. This flow signal controls an on-off recirculation valve for each pump, returning flow to the deaerator. The recirculation lines are connected to the pump discharge ahead of any valves.

For each unit the feed water flows from the main feed pumps through three high pressure heaters string. The heater string has three 190 percent size heaters arranged in series with upstream and downstream isolation valves. The upstream isolation valve will be a motor-operated three-way valve and the downstream isolation valve will be a motor operated stop-check valve. A 100 percent capacity bypass line will be piped common to each heater from the three-way valve.

For control of feed water flow during start-up, a pneumatically operated flow control valve will be provided at the economizer inlet, piped in parallel with the main stop- check valve. This control valve will be positioned from the control system which controls feed water flow. A stop-check valve will also be provided following this control valve.

The boiler feed water system will be all welded construction in accordance with ANSI 83'l.1, and the ASME Boiler and Pressure Vessel Code, Section I. Carbon steel, A106, Gr. B pipe will be used throughout the system. HP heaters are designed, fabricated, inspected, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest edition, and the Heat Exchange Institute (HEL) Standards for Closed Feed water heaters, latest edition.

The operating pressures, temperatures, and "pipe sizing" flow rates will be selected on the basis of data given above. Flow rates should be those occurring during boiler MCR and turbine Valves Wide Open. Pipe velocities for line sizing are generally limited to 6 meters per second (20 feet per second). The velocity entering the feed water heaters will be limited to 2.6 meters per second (8.5 feet per second). The maximum heater tube side pressure drop, including inlet and outlet losses, will be limited to 103 kPa (15 psi).

The high pressure heaters will be vertical shell and tube with integral drain cooling and desuperheating sections designed for 0°C terminal difference with 56°C drain cooler approach temperature. Tube material is preferred to be stainless steel.

CONDENSATE SYSTEM

The condensate system will be designed to pump and transport condensate from the hot well of the condenser, through the steam seal exhauster, and four stages of low pressure heating, to the deaerator, for heating and deaeration.

The condenser fill system will be designed to store condensate in an outside tank and to continuously add condensate to the condenser to maintain hot well level.

The condenser vacuum system will be designed to evacuate non-condensable from the condenser prior to startup, and to maintain condenser vacuum at all loads.

Summary Description of the system and design

The condensate system for each unit consists of one, dual shell, single pressure, three pass, transverse, main condenser; two 100 percent capacity, motor driven, vertical condensate pumps; one steam seal exhauster; five stages of low pressure heating (including the deaerator), two 100 percent capacity vacuum pumps, and condensate storage tanks.

The condensate storage tanks are dome-roof, field erected, steel tanks. The interior surfaces of the tanks are sand-blasted and coated with epoxy paint.

Non-condensable are removed from the condenser, by two 100 percent capacity vacuum pump packages.

Condensate from the condenser hot well flows to each pump suction through separate suction pipes, each with a temporary single basket strainer for start-up, a shutoff valve, and an expansion joint at the pump.

At full load, with two of the 50 percent capacity pumps operating at adequate rated speed condensate will be delivered to the system. The third pump will start automatically on a trip of any of the two operating pumps. Condensate will be delivered to a common discharge header. Each pump discharge is proposed to be equipped with a check valve, a gate valve, and a minimum flow recirculation line to the condenser. The minimum flow recirculation valve opens automatically on a signal from a differential pressure switch.

Condensate from the header flows through the steam seal exhauster, then to the low pressure heaters in the condenser necks. A check valve will be located in the header, downstream of the steam seal exhauster, to prevent complete drainage of the vertical header, on a pump trip.

A main recirculation line will be provided to recirculate pump flow from the header (between the steam seal exhauster and the check valve), to the condenser. The flow control valve in this recirculation line will be set to pass the minimum allowable flow for the steam seal exhauster, during times when there will be no unit load. This valve will be modulated by a signal from the flow nozzle located downstream of the steam seal exhauster. A full flow bypass is proposed to be provided around the gland steam condenser, this will permit the turbine to remain in operation with a tube side leak in the gland condenser since the motor driven exhausters will maintain gland vacuum, at a reduced efficiency, without cooling.

A three-way bypass valve provides a common bypass for the heaters in the condenser neck with a stop-check at each heater outlet. The three-way valve and isolation valve are motor operated, with control switches on the main control board.

These valves also switch automatically to heater bypass, on high-high heater level, to protect the turbine from water induction in accordance with ASME Standard TWOPS-1.

Deaerator

The condensate system will be all welded construction in accordance with ANSI B31.1. Piping is proposed carbon steel A106 Gr. B seamless. Valves are in accordance with ANSI B165 and 616.34

The condensate system will be designed to meet the flow and pressure requirements at all expected conditions and to provide stable operation during the most severe transient condition. The most severe transient occurs on a full load trip, with the condensate pump running back at maximum speed to minimum recirculation flow.

The condensate system will be capable of responding to a 10 percent step-load or 5 percent (per minute) ramp changes without major deviation from normal operation.

The condenser shell and waterside are designed to be in accordance with the requirements of the seventh edition of the HEI Standards for Steam Surface Condensers, Section 6, and Condensers Construction Standards. The condenser will be a two pass, single pressure, transverse condenser with 3 minutes condensate storage. Condenser's circulating water temperature rise will be 11°C.

Tube-material is preferred to be stainless steel with tubes 25 mm in diameter.

The deaerator and deaerator storage tank will be designed, fabricated inspected, tested and stamped in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest edition, and the HEI Standards. The deaerator storage tank will have a storage capacity of 10 minutes (80/IOOM3) and will be designed to limit oxygen content to 50 ppm. The condensate storage tanks are designed in accordance with AWS 05.2 (AWWA 0100) Standards for Steel Tanks.

The condensate pumps will be vertical can-type with cast iron casing and stainless steel impellers. They will be designed for the \/\NO flow rate and at least 5 percent margin. (3x5O% of approximately WOM"/h ea-)The design pressure will be based on the pressure drop from the system components, piping, and the static head between the deaerator and the pumps.

CIRCULATING WATER SYSTEM

The primary function of circulating water system is to condense the turbine exhaust steam in condenser and to reject this heat to atmosphere via cooling tower.

The secondary function of this system is to provide cooling for the other heat exchangers for Turbine oil coolers and Generator air coolers including closed cycle cooling water system heat exchanger.

A closed loop circulating water system has been proposed comprising of induced draft cooling towers and circulating water pumps and connecting piping.

Two cooling towers shall consist of 8 cells each having fill grid, drift eliminators, fans, motors and speed reduction gear. Drift eliminators will be used to remove entrained water droplets in the air discharging from the tower. The cooling towers shall be designed to produce 11 ^{0}C reductions in circulating water temperature.

5 circulating water pumps each of adequate capacity have been proposed for two units. Two circulating water pumps will be working for each unit condenser while one pump will be standby to be utilized for either unit. In order to maintain the requisite concentration number of circulating water, blow down will be provided and water so discharged will be utilized for arboriculture in project area.

Make up water, to replace evaporated water, blow down and drift, will enter the cooling tower basin through a motor operated control valve.

The source for cooling water will be river water which will be available in sufficient quantity to meet the plant requirement as described earlier in section 5 of the report.

In order to control pH of circulating water, sulphuric acid dosing system near fore bays will be provided in addition to chlorine injection system to control biological growth which could inhibit heat transfer in the condenser and other heat exchangers.

To maintain water storage a covered concrete tank having a capacity of 7,000 m^3 considered sufficient for 8 hrs has been provided.

AUXILIARY COOLING WATER SYSTEM

The auxiliary cooling water system will be designed to cope with the cooling requirement of following auxiliary equipment:

i) Feed water pumps

ii) Sample coolers

iii) Condenser pumps etc.

Two (2) water to water cooled heat exchangers will constitute part of the system. On the primary side of heat exchangers circulating water will be supplied from the main cooling water system and on the secondary side clarified water will circulate in a closed circuit.

In order to maintain circulation of clarified water from comprehensive pump house 3 pumps will be provided to operate in 2 + 1 configuration i.e. two pumps will remain in operation whereas one pump will be standby.

WATER TREATEM ENT PLANT

- **Water Desilting and Clarification Plant**

Water supplied from canal intake pumps and stored in the desilting pond will be clarified by employing coagulation and filtration process. Coagulant will be added

into water for clarification of canal water, i.e. removal of coarse and fine suspended matters, colloid-dispersed matters.

To increase effect of water clarification, i.e. to increase the degree of clarification at simultaneous decrease of ferric chloride flow rate, polyacrylamide will be added into water.

Preparation and storage of coagulant and polyacrylamide solution will be provided within the cells and tanks, located near the pond.

Total capacity of this plant will be 2 x 250 M^3/h with one half in service. This water will be pumped to the power plant through pipe line for use in auxiliary cooling water circuit, make up for cooling towers and steam boilers, service water and drinking water.

- **Demineralization Plant**

Makeup boiler feed water will be demineralized by a Demineralization Plant consisting of cation exchanger, degasification, anion exchanger and mixed bed units. Also included are the storage and feeding of regenerating caustic and sulfuric acid, and appropriate local controls, including neutralization controls. Spare acid and caustic pumps and the neutralization air mixing system will also be included.

After the process, the water results should be as given below:

Hardness~0µmol/L

SiO2~20µg/L

conductivity~O.2µs/cm

Regeneration waste is stored in a neutralization tank, where the waste is mixed and neutralized before it is sent to the dirty water sewer. Acid and caustic pumps will be provided for neutralization. Demineralized water will be stored in two storage tanks and pumped to the condensate system by the demineralized water pumps.

Operating philosophy envisages one train in operation while the other being recharged.

NEUTRALIZATION & WASTE WATER TREATMENT

All the effluents of the power plant will be treated to meet the requirements of the World Bank standards / NEQS. These will be routed through the neutralization tank before being discharged. The capacity of the neutralization basin will be such that all effluent will be taken up and neutralized. There will be two pumps of 100% capacity each, emptying the basin in one hour with one pump in operation.

All effluent after neutralization will have a pH value in the range of 6 to 9 before being disposed off, the pH value in the pressure line of the pump will be continuously measured/monitored and recorded at the panel.

More than 0.5% vertical grade on the bottom of channels will be made having internal collecting sumps connected to the rainwater drainage system for water removing.

The various mode of pipelines layout in the plant area includes direct embedment, underground ditches and overhead layout.

The pipes used for direct embedment layout will be circulating water pipes, makeup water pipe, firefighting water supply pipes, domestic water supply pipes and industrial water pipes. Demineralized water piping will be overhead.

COAL AND LIME STONE HANDLING SYSTEM

Coal will be delivered to power plant by trucks via one weigh bridges to a coal shed. Coal stored in the storage shed will be shifted by four overhead grab cranes each of about 180t/h capacity to four underground slot bunkers and reciprocating feeders.

There will be two fire-proof belt conveyors having average velocity of 1.6m/s with scaling, de- iron as well as sampling devices. Dual conveyor system to transfer the coal to the rushing station for crushing and screening is adopted for increasing reliability. Normally one belt will operate and other will be standby. The provision shall be made to use the stand by conveyor belt after coal crusher for lime stone transfer as well in case of emergency.

Each conveyor line will be capable of handling coal at the rate of 50 metric tons per hour against hourly consumption of approximately 160 tons. While designing the belt system, the appropriate value of k_Y factor (Resistance of the belt of flexure as it moves over the Idlers), the drive coefficient of friction and the load factor for belts will be selected in view of width and velocity given above. The four stages of coal conveyor system ie, 1 to 4 a b are shown in coal and limestone handling system.

Two crushers one each for a conveyor line will be installed to crush all fuel to 6-10 mm maximum particle size. The crushers will have bypass capability when filling the units 1 & 2 bunkers to conserve energy and to prevent the creation of additional dust.

In coal crushing and screening, the raw coal passes through a magnetic separator and will be fed to third conveyor line.

The vibrating screen with 6mm square holes under the crusher will control the product top size.

The product-size material will be conveyed away by a high angle conveyor and deposited in the coal bunkers at boilers, the coal bunkers will be sized for 8-hour feed to the boiler.

Each line of the conveying system will consist of weigh belt feeder, a gathering conveyor and an elevating conveyor. One system will be operating continuously while the other will be standby / spare.

To control any dust emissions, dust collection system consisting of water spry, filter bags and fans in enclosed ducts having conveyor system will be adopted.

Sized limestone will be received in the plant via trucks on a daily basis. The sized limestone will be conveyed to a 2,500 ton (7-day) capacity limestone storage shed adjacent to coal storage using the truck trailer.

Exhaust air from this filling operation will also be vented through a dust control filter system. The material from the limestone silo will then be fed at a controlled rate by

a weigh feeder and lifted by third conveying line feeding the boiler. Provisions may be included to transport limestone to the limestone feed hopper by belt conveying.

The limestone will be discharged from the limestone silo and fed to the pneumatic conveying line by rotary airlock feeder or by gravity. Two redundant systems will be provided with one operating and the other as standby spare.

- **Electrical Shop**

It will be equipped for rewinding of small motors and stands for adjustment / checking of electrical equipment / apparatus. Testing facility for testing of relays/instruments and high voltage tests will also be included.

ELECTRICAL EQUIPMENT

General

The major electrical equipment of the Coal Fired Power Plant is shown schematically in Single Line Diagram No. 8.7. All the other electrical equipment necessary for the plant shall conform to international standards.

It is worth mentioning that while selecting the electrical equipment following criteria will be observed.

i) Maximum output, minimum losses, longer life and minimum maintenance.

ii) The selected equipment should be easily available in international markets on competitive prices.

iii) Ensuring availability of spare parts for the useful life of the Plant.

The vital electrical equipment and systems are briefly described as under:

Steel Structures

The steel structure shall support bus bar conductors and overhead earth wire, The design and arrangement of supporting structures shall be similar to the WAPDA's approved one. Gantry masts and beams shall be of the lattice-type frame composed of standard angle members, supporting structures shall be of any frame with the main members composed of standard sections such as angles, channels, beams, etc. Structural steel shall be of high tensile strength steel for gantry masts and beams, and standard steel for supporting frames as per ASCE requirements or equivalent Standards. All structural parts shall be galvanized.

The masts shall be erected with concrete foundations, calculated in accordance with relevant ASCE Standard.

Structures for one-sided pull of conductors shall be designed for one-sided pull of two conductors per system. In the design and construction pull of conductors ASCE Standards shall generally be applied.

Galvanization shall be according to relevant ASTM Standards with a minimum thickness of zinc of 70 micrometer corresponding to 500 g/mi. No bolt shall be less in diameter than 12 mm for all bolts exposed to mechanical stress

In dimensioning of steel structures a minimum clearance of 2.25 meters from live parts shall be considered for 132kV.

Cabling System

XLPE insulated & PVC sheathed copper core Power Cables will be used for 6.6KV Power. PVC insulated and PVC sheathed copper core Power Cables will be used as 380V Power cables.

500V PVC insulated and PVC sheathed copper core armoured cables is chosen as control cables.

Twisted line shielded & overall shielded cables will be used as computer cables.

Main power building Cable raceway system; Cable raceway in the turbine building &boiler building will be mainly cable tunnel, Cable will be laid through conduct from cable tunnel to the equipment's in 0.0m floor (totally enclosed).

Fire resistive material will be used for the cable passage in order to prevent spreading of the fire in the plant.

INSTRUMENTATION AND CONTROL

The I & C system will be designed and realized according to the actual requirement for modern, proven in operation, hardware and software means to achieve high degree of safety, reliability and process automation.

The plant shall be capable of automatic operation and control of all variables except coal and ash handling from a central control room over the range of 30% to 100% MCR.

For coal and ash handling control system, a separate control room is envisaged located in between coal storage shed and boiler. It will have independent PLC based control and instrumentation systems as well as integrated with plant DCS.

The central control room will be equipped with indications of all significant parameters required to proficiently regulate the output of plant and keep variables to their set points. Indications and recording of all important parameters like operational power metering, fuel input, steam/feed water flow etc as well as printer logging shall be provided.

Under normal conditions, the plant will be controlled automatically with little intervention of operators. Conditions considered other than normal will be alarmed so that the operator may take immediate corrective action.

The following major automatic controls will be provided to maintain the CFB boiler system at optimum operating conditions.

- Boiler master control for control of boiler load by variation of fuel and air supply.
- Superheater & reheater steam temperature control

- Combustor temperature control by variation of fuel and air and variation of ash flow
- Furnace differential pressure control to control the solids inventory in the combustor by variation of ash extraction from combustor.
- SOX control by varying the limestone injection.
- Furnace draft control for maintaining the pressure after cyclone
- Boiler primary and secondary air control system
- Chain Grate temperature of furnace control system
- Chain Grate pressure of furnace control system
- Temperature of reheat steam control system
- Temperature of slag cooler control system
- Condenser water level control system
- Deaerator pressure control system
- Deaerator water level control system
- High-pressure heater water level control system
- Low-pressure heater water level control system etc.

The DCS will be capable of asset management, process control and management execution through intelligent field devices, industry standard platforms and integrated modular software including field bus at field level, Ethernet at plant level and OPC at the supervisory level to improve plant performance, reliability and profitability.

The DCS shall have a high level of availability of at least 99.9% to preserve reliable operation and shall employ redundancy of CPU and facilities at the supervisory level including Human Machine interface (HMI) levels.

The system with its distributed structure will Lisa both the parallel and serial data processing and data transmission, according to the technological process in different function groups. It will include information system, equipment status, failure messages, graphics, measurements and recoding. The control system will assume local as well as remote control from central control room.

Plant level and HMI level communications basis shall be configured to provide redundant communication paths so that communication remains unaffected by single path failure.

The DCS will perform the unit performance calculation, historical data memory and index etc. with displays like Group display, Alarm display, Trend display, Sequence of event etc.

Technological specifications of the project will cover the following:

- Coal handling system
- Ash handling system
- Boilers 1 & 2
- Steam Turbines 1 & 2
- Oil treatment plant of Steam Turbines
- Condensate System
- Feed Water System
- Cooling Water System
- Chemical Water Treatment Plant
- HV/MV/LV switchgear
- Home consumption

The telecom and SCADA system compatible with NTDC connected substation will also be provided for telemetering and 220 KV breakers operation by National Power Control Center (NPCC) at Islamabad.

HSD Storage Tanks

Concrete raft foundations have been proposed for the two 50m3 each HSD storage tanks keeping in view its large surface area and foundation conditions.

Water Treatment Plant

The chemical water treatment plant is to be designed for production of demineralized water and dosing of chemicals. The plant will be in close vicinity of turbine hall. The foundation will be designed as a raft foundation. The foundations and basement structures will be designed as monolithic reinforced concrete.

Near the chemical water treatment plant RCC foundations for dematerialized water tanks shall be provided.

Water Storage Tank

An underground reinforced concrete storage tank for raw water from Canal intake will be provided. The dimensions of the tank will be about 35 x 50 x 4.5 meters. The tank will have capacity of about 7000 m^3.

Circulating Water Pump House

The circulating water pump house will be designed as semi-underground structure to accommodate five vertical CW pumps, normal and emergency firefighting pumps. It will also accommodate all valves including hydraulically controlled check valves. The proposed dimensions are 20x50m with 8m above ground and 4m underground.

HYTEX ENERGY (Pvt.) LIMITED
5 MW COAL FIRED POWER PLANT

BOILER No. 1 DATA		
INPUT DATA	**UNIT**	**VALUES**
Make		MITSUBISHI
Capacity	Tone / Hour	15
Pressure	Bar	25
Temperature	celsius	350

BOILER No. 1 DATA		
Make		MITSUBISHI
Capacity	Tone / Hour	30
Pressure	Bar	45
Temperature	celsius	350

TURBINE No. 1 DATA		
Country of origion		**Japan**
Model		SHINKO
Type		CONDENSING
Power Rated/Max	K. W.	1500
Exhaust Steam Pressure	Bar	0.007
Rated speed	RPM	6000
Inlet Steam Flow	Ton per Hour	11
Inlet Steam Pressure	Bar	25
Inlet Steam Temperature	celsius	350

TURBINE No. 2 DATA		
Country of origion		**Japan**
Model		SHINKO
Type		CONDENSING
Power Rated/Max	K. W.	3500
Exhaust Steam Pressure	Bar	0.007
Rated speed	RPM	6000
Inlet Steam Flow	Ton per Hour	25
Inlet Steam Pressure	Bar	45
Inlet Steam Temperature	celsius	350

ENERGY GENERATION DATA		
Number of Turbines in Plant	No.	2
Targeted Hours in Year	Hours	8760
Expected Maintenance down time per year	Hours	760
Plant size	KW	5000
Operating Time per year	Hours	8000
Load Factor (85 % Eff.)		4250
Energy generation per year	KWh	34,000,000
Parasitic load Per Year 500 KW (10%)	KWh	4,000,000
Energy generation per 10 years	KWh	340,000,000

STEAM COST ANALYSIS		
Coal Consumption per KWh	Kg / KWh	1
Present rate	Rs. / Kg	8
Transportation Cost	Rs. / Kg	3
Cost of Energy	Rs. / KWh	11

FUEL COST		
Total **Steam** Required per Hour	Tone	13
Lime Stone Consumption per ton of Steam	Kg / Hour	NIL
Energy Generated Per Hour	KWh	1275
Cost of Total Energy Generation	Rs. Per Hour	14025
Cost of Fuel	**Rs. Per KWh**	**11**

MAN POWER COST		
1 - General Manager	Rs. Per Month	
1 - Turbine Engineer	Rs. Per Month	0
1 - Boiler Engineer	Rs. Per Month	0
1 - I.T Engineer	Rs. Per Month	0
1 - Electrical Engineer	Rs. Per Month	0
Workshop Staff	Rs. Per Month	0
Laboratory Staff	Rs. Per Month	0
Administration Staff	Rs. Per Month	0
4 - Shift Managers	Rs. Per Month	0
4 - Shift Engineers	Rs. Per Month	0
8 - Fitteers	Rs. Per Month	0
8 - Helpers	Rs. Per Month	0
Operation & Maintenance Costr Per Year	Rs.	7,800,000
Cost of Man Power Per KWh	**Rs.**	**0.23**

FINANCIAL COST		
Cost of 1 X 1.5 MW Turbine (Package)	USD	300,000.00
Cost of 1 X 3.5 MW Turbine (Package)	USD	750,000.00
Cost of 15 tph Coal Fired Boiler (Included)	USD	600,000.00
Cost of 30 tph Coal Fired Boiler (Included)	USD	1,000,000.00
Chain Grate 2 Sets	USD	145,000.00
Economizer	USD	27,500.00
Slag Remover	USD	21,480.00
Gear Box	USD	12,664.00
Coal Feeder	USD	8,400.00
Induced Draft Fan	USD	15,612.00
Induced Draft Fan Inverter	USD	7,068.00
Forced Draft Fan	USD	10,132.00
Forced Draft Fan Inverter	USD	6,668.00
Multi-tube Dust Remover	USD	34,864.00
Air Preheater	USD	28,900.00
Air Superheater	USD	21,340.00
PLC Control Cabinet	USD	20,200.00
MCC	USD	10,000.00
Coal Crusher	USD	18,668.00
Cost of Control Panels (Included)	USD	10,000.00
Toatl cost in USD	USD	3,048,496.00
Total Cost in Pak Rs. 100/USD	Rs.	304,849,600.00
Cost of Piping and Insutruments (Included)	Rs.	10,000,000.00
Cost of Cooling Towers With Pumps	Rs.	20,000,000.00
Cost of Condensers (Included)	Rs.	5,000,000.00
Cost of Sub Station Equipment	Rs.	5,000,000.00
Cost of Syncronizing System with HESCO 11 KV	Rs.	4,000,000.00
Cost of Water Treatment Plant 2 Sets	Rs.	10,000,000.00
Cost of Installation, Turn Key Basis (Included)		
Cost of Consultancy Charges		2,500,000.00
Cost of Transportation upto Hyderabad (Included)		
Total Cost of 5 MW Power Plant	Pak Rs.	361,349,600
Total Financial Cost (For first 5 years)	Rs. Per KWh	1.151

PER KWH COST ANALYSIS		
Cost of Fuel Consumption	Rs. Per KWh	11.00
Cost of Financial Charges	Rs. Per KWH	1.151
Cost of Man Power	Rs. Per KWh	0.23
Cost of Maintenance (Lump Sum)	Rs. Per KWh	0.2
Total Electricity Cost	**Rs. Per KWh**	**12.58**

SAVINGS		
Cost of Utility (Governmental cost of Electricity)	Rs/KWh	16
Cost of Gneneration	Rs/KWh	12.580
Savings over utility	Rs/KWh	3.420
Savings per year	Rs/KWh	102,587,647
Saving in 10 years		1,162,660,000
Pay Back Period	**YEARS**	**3.52**

PROSPECTUS

HYTEX ENERGY (PVT) LTD GROUP

(FORMER HYTEX)

PROFILE

INTRODUCTION

HYTEX ENERGY (PVT) LTD GROUP(Former HYTEX) comprises of AKS Textile and HYTEX both the units are involved in Textile products, same are in operation since more than one decade. Manufacturing of high quality fabric for USA and Europe market. The HEPL GROUP initially introduced its products in the local market. It was nearly after a decade when a Group ventured into the international market of Europe and United States of America. Further achieving another mile stone now exporting value added fabric after Processing cloth through their sister concern industries in Karachi.

ENERGY GENERATION EXPERTISE

After successful operation of Textile Industries HYTEX was registered in S.E.C.P as HYTEX ENERGY (PVT) LTD introduces **HYTEX ENERGY (PVT) LTD** accordingly under the banner of HYTEX ENERGY (PVT) LTD installed of 1.5 MW which is in operation for in house consumption & enhancement of 3.5 MW Power Plant installation is in progress and soon will be ready for commissioning, immediately after commissioning of aforesaid plant erection of another similar plant will start which would be around 49.9 MW Coal Fired Power Plant as N SPP

HYTEX ENERGY (PVT) LTD is proud to announce that this would be the first COAL Power Plant one of its own kinds in Pakistan in private sector. HYTEX ENERGY (PVT) LTD would sell Electricity to local DISCO

HYTEX ENERGY (PVT) LTD continuous striving on coal Power Projects to overcome Pakistan energy crises and simultaneous fuel crises, to overcome the problem **HYTEX ENERGY (PVT) LTD** is importing **50 MW COAL POWER PLANT** from reputed European Manufacturer, in this regard HEPL has hired Canadian Firm as their EPC Contractor. Letter of Credit would shortly be established.

Government's National Transmission & Distribution Company (NTDC) as Buyer of electricity is readily available on pre-determined Tariff.

SELECTION OF TECHNOLOGY & UNIT SIZE OPTIMIZATION

In Pakistan majority of Small Power Producers are based on Natural Gas, but since last 3 years due to shortage of Natural Gas many Gas Fired Power Plant and industries close down as the GAS reserves are almost exhausted in Pakistan. Furnace Oil and Fuel are not viable because of their higher import price and Government Taxes.

As compared to other available fuel Local Coal that is easily available and very near to Plant site in Hyderabad and in huge quantity, and in very economical price as compared to other Fuels.

Further it is stated that Lakhra Coal field is fully developed and contains mineable coal reserves of 146 Million Tones. Sindh Coal is classified as Lignite with calorific value ranging from 5219 to 13555 Btu / lb.

Feasibility studies on Coal carried out by various agencies including John T Boyd of USA have confirmed mine ability and suitability of Coal mining from the area. Lakhra coal contains high sulfur and high ash.

Various studies carried out by national and international organization including the following:

- WPIDC
- GSP
- JICA
- John T boyd
- USGS

All the above organization has confirmed that Lakhra Coal is suitable for Power Generation. Lakhra Coal being an indigenous fuel is most suitable for generation of at cheap rates. Power generation from Lakhra Coal will reduces the burden on foreign exchange which is already short in the country

ECONOMIC AND FINANCIAL ASPECTS

Estimated cost of project of 50 MW Coal Power Project is USD 50 Million including cost of Land, Building Construction and local procurement, as agreed by financial institution first two years would be interest free loan. Edge provided to give relive from Financial Charges and Bank installments on account of transportation and installation time margin, thereafter the Pay Back period would be 2+5 years on agreed terms and conditions.

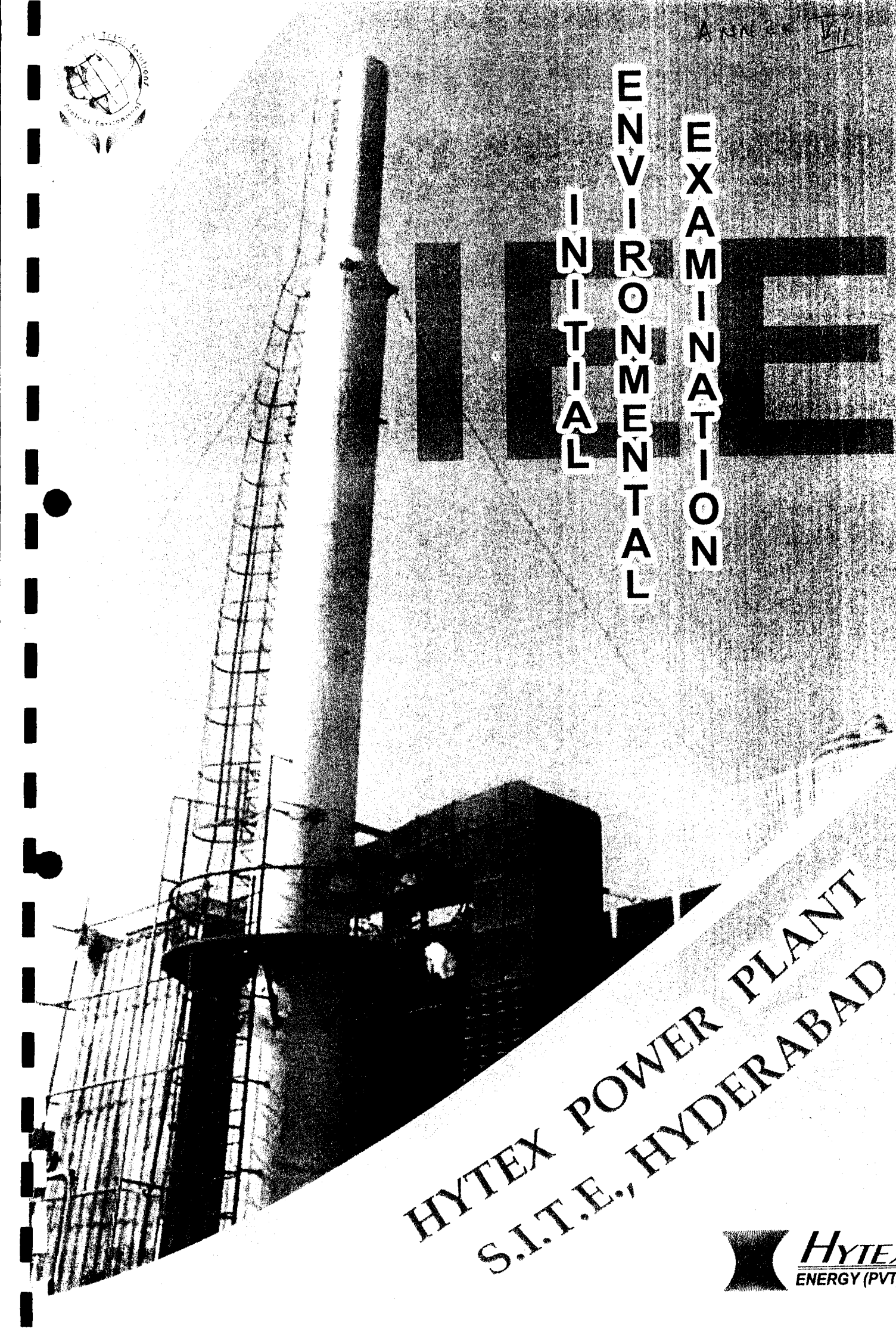
OUTCOMES

After paying monthly Bank Financial charges and Bank monthly installment Profit per month shall be USD 941,145/=

In first five years expected saving per year would be USD 11,293,743/= On 6th year and onwards expected saving per year would be USD 26,038,743/= Pay Back Period is 4.38 years. Detailed Executive Summary attached herewith for ready reference in ANNEX I

ANNEX VII

INITIAL ENVIRONMENTAL EXAMINATION



HYTEX POWER PLANT
S.I.T.E., HYDERABAD

HYTEX ENERGY (PVT) LTD

INITIAL ENVIRONMENTAL EXAMINATION 2014

HYTEX ENERGY PVT. LTD.

B-5, S.I.T.E. Area, Hyderabad

Environmental Total Solutions

Office No. 1, Aqsa Tower, Main Rashid Minhas Rd. Karachi

Contact: 03332277350,

Email: Etspk41@yahoo.com & iqbalh41@yahoo.com

Executive Summary

With the policy of privatization of the power industry and liberalized -schemes formulated by the Govt. of Pakistan for setting up bio mass power plant by private enterprises and in view of the Energy policy as announced by State Govt. project proponent has decided to set up 5 MW Biomass Cogeneration Power Plant at S.I.T.E Area, Hyderabad to generate power utilizing biomass as the main fuel and coal, as the supplementary fuels.

This report presents the findings of Initial Environment Examination (IEE) study carried out by Environmental Total Solutions (ETS) for proposed 05MW Cogeneration Power Plant at Hytex Energy Pvt. Ltd., T.M. Khan Rd., S.I.T.E. Area, and Hyderabad.

The IEE has been prepared in compliance with the requirements of Pakistan Environmental Protection Act (PEPA) 1997, Pakistan Environmental Assessment Procedures, 1997 and Pakistan Environmental Protection Agency (Review of EIA/IEE) Regulations-2000.

The project contribution to sustainable development

This project activity has excellent contribution towards sustainable development and addresses the key issues:

Environmental well-being

- Substituting the electricity requirement from grid by co-fired plant there by eliminating the generation of equivalent quantum of electricity using conventional fuel feeding the national grid.
- Conserving fossil fuel and other non-renewable natural resource.
- Mitigating the emission of GHG (CO_2).

Socio- economic well being

- Contributing to a small increase in the local employment by employing skilled and unskilled personnel for operation and maintenance of the equipment.
- Adopting an advanced and sustainable technology for long term benefits.

- Helping to bridge the gap of electricity demand and supply at local level.

Objective

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 will generate 13 MW of electricity with 08 MW internal consumption by the factory and 05 MW export to the national grid.

- **Categorization of the project**

  The project would be placed in category B, Schedule I, requiring an IEE study due to:

  - Low sensitivity of the micro environment in which the 13 MW power plant is being sited,
  - Impact of different activities including construction, installation, commissioning and operation being confined to and localized into the microenvironment of Tando M. Khan road. SITE Area, Hyderabad.

SUMMARY

As a result of the production of this Environmental Impact Assessment Scoping Statement, the following significant potential impacts of the Blackburn Meadows Renewable Energy Plant have been indicated. Other effects will also occur which will be investigated, but these are considered the most significant.

Air quality	Emissions of greenhouse gases and other emissions;
Emissions from traffic movements;	Dust levels during construction;
Flood risk	Identification of any mitigation works which may be needed during the development stage of the project;
Ecology	Direct and indirect impacts on statutory and non-statutory designated sites; Scope for biodiversity enhancements;

Transport	Increase in road movements during construction and operation; Inter-action with other proposed transport schemes;
Noise	Temporary noise increases during construction; Noise during operation;
Landscape and Visual	Visual aspects of the proposed plant; Building design;
Socio-economic	Potential for job creation during construction; Potential employment at the Blackburn Meadows Renewable Energy Plant;
Energy/sustainability	Contribution to the City's sustainable energy strategy;

List of Abbreviations

AAQM	Ambient Air Quality Monitoring
ACW	Auxiliary Cooling Water
ADP	Asian Development Bank
ARE	Alternative/Renewable Energy
BFB	Boiler Feed Pump
BA	Bottom Ash
BOD	Biological Oxygen Demand
CCPP	Captive Co-generation Power Plant
CCS	Carbon Capture & Storage
CDM	Clean Development Mechanism
CFBC	Circulating Fluidized Bed Combustion
CHP	Combined Heat & Power
CO	Carbon monoxide
CO_2	Carbon dioxide
COC	Cycle of Concentration
COD	Chemical Oxygen Demand
CMI	Census of Manufacturing Industries
CPCB	Central Pollution Control Board
CRE	Combustible Renewable Energy
CSO	Clarified Slurry Oil
CSR	Corporate Social Responsibility
CW	Cooling Water
DO	Dissolved Oxygen
DM	De-mineralized
DMC	Developing Member Countries
EBM	Environmental Best Management
EIA	Environmental Impact Assessment

EMP	Environment Management Plan
EPA	Environmental Protection Act
ESP	Electro-Static Precipitator
ETS	Environmental Total Solution
FA	Fly ash
GBEP	Global Bio-energy Partnership
GDP	Gross Domestic Product
GHG	Green House Gasses
GLC	Ground Level Concentration
HESCO	Hyderabad Electric Supply Company
HSE	Health, Safety and Environmental
HWMHTM	Hazardous Waste (Management, Handling and Tran's boundary Movement) Rules
HP	High Pressure
IEA	International Energy Agency
IEE	Initial Environmental Examination
IPCC	International Panel on Climate Change
IMD	Indian Meteorological Department
LBOD	Left Bank out Fall Drainage
N	North
NE	North East
NEQS	National Environmental Quality Standards
NOC	No Objection Certificate
NOx	Oxides of Nitrogen
OECD	Organization for Economic Co-operation &Development
PEPA	Pakistan Environmental Protection Agency
PEPC	Pakistan Environmental Protection Council
PM	Particulate Matter
$PM_{2.5}$	Particles less than 2.5Micrometer
PM_{10}	Particles less than 10 Micrometer

PPE	Personnel Protective Equipment
RCC	Reinforced Cement Concrete
RBOD	Right Bank out Fall Drainage
SEPA	Sindh Environmental Protection Agency
SITE	Sindh Industrial Trading Estate
SG	Steam Generator
SPL	Sound Pressure Level
SPM	Suspended Particulate Matter
SO_2	Sulfur dioxide
STG	Steam Turbine Generator
SW	South West
TDS	Total Dissolved Solid
TOR	Terms of Reference
WHRB	Waste Heat Recovery Boilers
UNDP	United Nations Development Program
UNFCCC	United Nations Frame Work Convention on Climate Change
UNESCO	United Nations Educational, Scientific & Cultural Organization
UNESCAP	United Nations Economic & Social Commission for Asia & Pacific

Units

^{0}C	Degree Celsius
Exajoule	One Billion joule
^{0}F	Degree Fahrenheit
ha	Hectare
dB(A)	Decibel (A-rated)
GW	Giga Watt
ha	Hectare
Kw	Kilowatt
KWh	Kilowatt-hour
Nm^3/h	Normal cubic meter per hour
mg/Nm^3	Micro gram per normal cubic meter
mg/l	Mille gram per liter
mm	Mille meter
MW	Megawatt
mW	Milliwatt
Wh	Watt-hour
µm	micrometer

Technical Terms Used in Power Generation

Alternative fuel:

- Methanol, denatured ethanol, etc, separately or in blends of at least 10 percent by volume with gasoline or other fuels
- Compressed natural gas
- Liquefied natural gas
- Liquefied propane gas
- Hydrogen
- Coal derived liquid fuels
- Fuels other than alcohols derived from biological materials
- Electricity
- Biodiesel
- Any other fuel determined to be substantially not petroleum and yielding potential energy security benefits and substantial environmental benefits.

Background level

The average amount of a substance presents in the environment that originally referring to naturally occurring phenomena. Used in toxic substance monitoring.

Backup rate

Backup rate is a utility charge for providing occasional electricity service to replace on-site generation.

Backup electricity, backup services

Power or services needed occasionally; for example, when on-site generation equipment fails.

Baffle chamber

In incinerator design, a chamber designed to settle fly ash and coarse particulate matter by changing the direction and reducing the velocity of the combustion gases.

Bag house

A chamber containing fabric filter bags that remove particles from furnace stack exhaust gases. A bag house is used to eliminate particles greater than 20 microns in diameter

Base load capacity

The power output that generating equipment can continuously produce.

Base load demand

The minimum demand experienced by an electric utility, usually 30-40% of the utility's peak demand

Best available control measures

The most effective measure for controlling small or dispersed particulates such as soot and ash from woodstoves and open burning of brush, timber, grasslands, or trash is at sources.

Best available control technology (BACT)

That combination of production processes, methods, systems, and techniques that will result in the lowest achievable level of emissions of air pollutants from a given facility. BACT is an emission limitation that the permitting authority determines on a case-by-case basis, taking into account energy, environmental, economic and other costs of control. BACT may include fuel cleaning or treatment or innovative fuel combustion techniques.

Best management practices (BMP)

A practice or combination of practices that a designated agency determines to be the most effective, practical means of reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals

Boiler horsepower

A measure of the maximum rate of heat energy output of a steam generator. One boiler horsepower equals 33,480 Btu/hr output in steam

Boiler

Any device used to burn biomass fuel to heat water for generating steam

Bottom ash

Noncombustible ash that is left after solid fuel has been burned.

British thermal unit (BTU)

A unit of heat energy equal to the heat needed to raise the temperature of one pound of water one degree Fahrenheit at one atmosphere pressure (sea level)

Capacity Factor

The ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full-power operation during the same period.

Combined Heat and Power (Cogeneration)

Combined heat and power (CHP), also known as cogeneration, is an efficient, clean, and reliable approach to generating power and thermal energy from a single fuel source. CHP is not a specific technology but an application of technologies to meet an energy user's needs. CHP systems achieve typical effective electric efficiencies of 50 to 80 percent — a dramatic improvement over the average efficiency of separate heat and power. Since CHP is highly efficient, it reduces traditional air pollutants and carbon dioxide, the leading greenhouse gas associated with climate change

Emissions

Anthropogenic releases of gases to the atmosphere. In the context of global climate change, they consist of radioactively important greenhouse gases (e.g., the release of carbon dioxide during fuel combustion).

Energy Efficiency

Energy efficiency refers to products or systems using less energy to do the same or better job than conventional products or systems. Energy efficiency saves energy, saves money on utility bills, and helps protect the environment by reducing the amount of electricity that

needs to be generated. When buying or replacing products or appliances for your home, look for the ENERGY STAR® label — the national symbol for energy efficiency.

Fossil Fuels

Fossil fuels are the nation's principal source of electricity. The popularity of these fuels is largely due to their low costs. Fossil fuels come in three major forms-coal, oil, and natural gas. Because fossil fuels are a finite resource and cannot be replenished once they are extracted and burned, they are not considered renewable.

Generation (Electricity)

The process of producing electric energy from other forms of energy; also, the amount of electric energy produced, expressed in watt-hours (Wh)

Generation (Gross)

The total amount of electric energy produced by the generating units at a generating station or stations, measured at the generator terminals

Generation (Net)

Gross generation less the electric energy consumed at the generating station for station's use

Grid

The layout of an electrical distribution system

Kilowatt (kW):

One thousand watts of electricity

Kilowatt-hour (kWh):

One thousand watt-hours

Megawatt (MW)

One million watts of electricity

Renewable Energy:

The term renewable energy generally refers to electricity supplied from renewable energy sources, such as wind and solar power, geothermal, hydropower, and various forms of biomass. These energy sources are considered renewable sources because they are continuously replenished on the Earth

Transmission System (Electric):

An interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers, or is delivered to other electric systems

Turbine

Turbine is a machine that is used for generating rotary mechanical power from the energy of a stream of fluid (such as water, steam, or hot gas). Turbines convert the kinetic energy of fluids to mechanical energy through the principles of impulse and reaction, or a mixture of the two

Watt (Electric)

Watt is the electrical unit of power. The rate of energy transfer equivalent to 1 ampere of electric current flowing under a pressure of 1 volt at unity power factor.

Watt (Thermal)

A unit of power in the metric system, expressed in terms of energy per second, equal to the work done at a rate of 1 joule per second.

Watt-Hour (Wh)

Watt-Hour (Wh) is termed as the electrical energy unit of measure equal to 1 watt of power supplied to, or taken from an electric circuit steadily for 1 hour.

The combined crushing capacity of various sugar mills located in the country is more than 590,000 tons per day. Pakistan crushed 48,249,000 tons of sugar cane during the last crushing season (2011-12), which yielded over 15 million tons of bagasse assuming 32

percent fiber on cane. The amount of bagasse produced by sugar mills has the potential to generate over 2,000 MW. This power would be produced during the crushing season as well as at least a few months during the off-season depending on availability of saved bagasse from the season.

TABLE OF CONTENTS

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 05MW cogeneration (Biomass & Coal) power plant being undertaken at Hytex Energy Pvt. Ltd., located at Tando Muhammad Khan Rd. S.I.T.E. Area, Hyderabad, Sindh.

The IEE has been prepared in compliance with the requirements of Pakistan Environmental Protection Act (PEPA) 1997, Pakistan Environmental Assessment Procedures, 1997 and Pakistan Environmental Protection Agency (Review of EIA/IEE) Regulations-2000. Compliance with the Provisions of PEPA 1997, Section-12 required that:

"No proponent of a project shall commence construction or operation unless he has filed with the Government Agency designated by Federal Environmental Protection Agency or Provincial Environmental Protection Agencies, as the case may be, or, where the project is likely to cause adverse environment effects an environmental impact assessment, and has obtained from Government Agency approval in respect thereof."

1.2 THE PROPOSED PROJECT

The project comprises of construction, installation and operational stages of 05 MW Cogeneration (Biomass & Coal) power plants with waste heat recovery boilers (WHRB) and installation of steam turbine to produce electricity at Tando Muhammad Khan Rd., S.I.T.E. Area, Hyderabad, Sindh.

The area available for the Hytex Power Plant is given below:

Total Plant Area:	05 Acres
Biomass storage	0.5 Acres
Coal Storage (30 days):	0.5 Acres
Ash Storage (15 days):	0.5 Acres

The plant would be using local coal

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 coal fired boilers (02 in Nos. operating) each having a capacity of 10 TPH. Steam parameters at super heater outlet will be maintained at 25 Bar atm., 350°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 (2 Nos.), meeting the steam generation parameters within subcritical

1.3 PROJECT SALIENT FEATURES

1. Project Name	Hytex Energy Pvt. Ltd.
2. Project Location	T. M. Khan Rd. S.I.T.E. Area, Hyderabad
3. Project Proponent	Shoukat Khayyam
4. Project Design Parameters	As attached

Plant Configuration

a. Installed capacity	5 MW
(i) STG-1	1.5 MW
(II) STG-2	3.5 MW
b. De rated Capacity	4,250 KW
c. Parasitic Load	500 KW
d. In House Consumption	750 KW
e. Load Available for HESCO	3,000 KW
f. Type of Technology	Steam Turbines
g. Number of Generator	02 SET
h. Capacity of each Generator	5 MW (1.5 MW + 3.5)

i. Make and Model	SHINKO JAPAN
j. Gross Capacity	5 MW
Plant Characteristics	
Generator Voltage	11000 V AC
Frequency	50Hz
Power Factor	0.8 – 0.9
Auto Generation Control	Full Automatic
Ramping Rate	15 – 20 Sec
Alternative Fuel	Coal
Auxiliary consumption	500 KW
Time (s)	15 Sec.
Fuel Used	
a. Fuel Type	BIOMASS / COAL
b. Fuel (Imported / Indigenous)	LOCAL
c. Fuel Supply (Biomass)	D.B. Chandio and Associates
d. Fuel Supply (Coal)	Lala Dhani Bux Coal Agent
Water	
Cooling Water Source	Ground Water
Grid Station	
Name of Grid Station	T-20 (Tando Mohammad Khan Road)
Distance	02 km
Emission Values	
SO_x (mg/Nm^3)	410
NO_x (mg/Nm^3)	425
CO (mg/Nm^3)	800
Cl (mg/Nm^3)	150
CO_2	40%
PM_{10}	500

1.4 PROJECT OBJECTIVES

The project aims to produce electricity for supply to 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 to:

- Respond to the urgent need to close the widening gap between power generation and demand at Tando Muhammad Khan Rd., S.I.T.E. Area, Hyderabad, Sindh.
- Ensure stable power supply to 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.

1.5 NEED OF THE PROJECT

The need to the power project is spelled out by the recent statement of the Chief Executive Officer of the HESCO who held the following as being mainly responsible for fluctuation and tripping in the power generation system:

Old power supply system in Tando Muhammad Khan Rd., S.I.T.E. Area, Hyderabad, Sindh.
Distribution losses

The position with regard to availability of power has deteriorated and has compelled HESCO to go for forced load-shedding.

Initial Environmental Examination (IEE)

The objectives of the study is preparation of Initial Environmental Examination Report based on the EIA notification of 1997 of Pakistan Environment Protection Agency 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 2000 clearly define the categories of projects requiring an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) in Schedules I and II respectively.

According to Para 3 of EIA / IEE regulations-2000: "A proponent of a period falling in any category listed in Schedule I shall file an IEE with the Federal Agency, and the provisions of section 12 shall apply to such project".

According to Para 4 of EIA/IEE Regulations-2000: "A proponent of a project falling in submitting EIA/IEE in any category listed in Schedule II shall file an EIA/IEE with the Federal

Agency, and the provisions of section 12 shall apply to such project". Schedule II of the regulations includes "all projects situated in environmentally sensitive areas" and "any project likely to cause an adverse environmental effect."

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.

1.7 SCOPE OF THE IEE

This IEE investigates the impacts likely to arise from the different activities including construction, installation, commissioning and operation of the 13MW Cogeneration (Biomass & Coal) stand alone power generating unit (HYTEX), located at Plot No.B-5, S.I.T.E Area, Tando Muhammad Khan Road, Hyderabad, Sindh.

The IEE has been prepared to achieve the following objectives:

- Identification and investigation of likely impacts of the proposed activities during the different phases of construction, installation, commissioning and operations on the physical, biological, and socio-economic environment of the project area;
- Proposal of mitigation measures that would help the proponent in conducting the operations in an environmentally sustainable manner;
- Develop an Environmental Management Plan (EMP of effective implementation of the recommendation of the IEE.

1.8 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 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 Hytex site and in the downwind direction.
- AAQM 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 NEQS (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.

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.

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.

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 ORGANIZATION OF THIS REPORT

The report is organized in following sections;

STRUCTURE OF THE AUDIT REPORT

Chapter 1 Introduction

Chapter 2: Legislative Requirements

Chapter 3: Baseline Environmental Status

Chapter 4: Overview of Biomass & State of Technology

Chapter 5: Review of Alternatives

Chapter 6: Anticipated Environmental Impacts & Mitigation Measures

Chapter 7: Environmental Management Plan

Chapter 8: Conclusion

PROPONENT DETAILS

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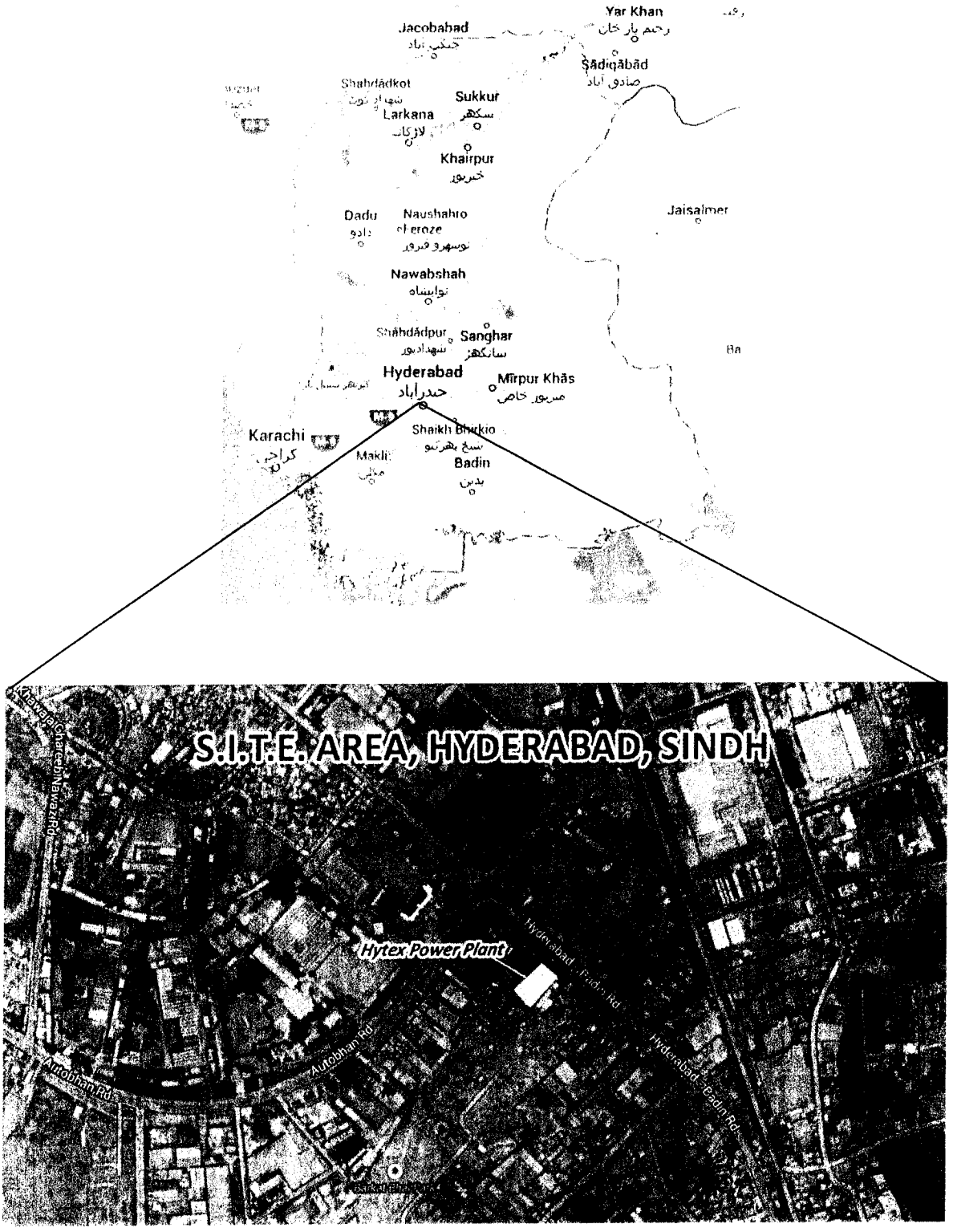
Location of Mills	B-5, Tando M. Khan Rd. S.I.T.E. Area, Hyderabad
Email	hytexweaving@hotmail.com, hytexweaving@yahoo.com
Year of Establishment	2014
Type of Industry	Energy Cogeneration power plant
Environmental Consultant	Environmental Total Solutions (ETS) Office No. 1, Aqsa Tower, Main Rashid Minhas Rd., Karachi. Contact: 0333-2277350 Email: Etspk41@yahoo.com, iqbalh41@yahoo.com

SATELLITE MAP OF HYTEX ENERGY Pvt. Ltd.



Legislative Requirements

2.1 NATIONAL LEGAL REQUIREMENTS

The Government of Pakistan has actively pursued the cause of environmental protection. It has been a party to several international declarations, agreements and conventions and has also ratified these documents. Pakistan has also created organizational structures and enacted rules for the protection of the environment. The Constitution of Pakistan contains provisions for environment protection and resource conservation. Several laws exist for the protection of the environment, which are discussed below.

Pakistan Penal Code 1861 (adopted from the British legacy), which is a general criminal law and applies all over the country, contains specific provisions on the subject. Thus it prohibits mischief by killing or maiming animals, or damaging works of irrigation, rivers, roads, bridges, drains or firing explosive substances with intent to cause damage. The Code also prohibits public nuisance by acting negligently to spread the infection of disease or disobeying quarantine rule or causing adulteration of food or drink or drug, or fouling water or making the atmosphere noxious to health etc.

The promulgation of the **Environmental Protection Ordinance, 1983** was the First codifying legislation on the issue of environmental protection. Later, the Government passed the **Pakistan Environmental Protection Act (PEPA), 1997**, which is the basis of IEE/EIA studies carried out for the projects in Pakistan

2.2 PAKISTAN ENVIRONMENTAL PROTECTION ACT, 1997

PEPA, 1997 is a fairly comprehensive legislation and contains stipulations for the protection, conservation, rehabilitation and improvement of the environment. It contains concrete action plans and programs for the prevention of pollution and promotes sustainable development. The salient features of the law are:

- It covers air, water, soil, marine and noise pollution including pollution caused by motor vehicles.

- The Act provides National Environmental Quality Standards (NEQS) for wastewater, air emissions and noise.
- The law provides clear cut guidelines for IEE/EIA for various projects as per their magnitude and anticipated impacts.
- The law also empowers the Federal Government to issue notices and to enforce them for the protection of the environment.

For the effective implementation of the provisions of PEPA, 1997, the Pakistan Environmental Protection Agency headed by a Director General has been constituted. On the same pattern, Provincial Environmental Protection Agencies (EPAs) have been created in all the provinces. Environmental Tribunals have also been constituted according to PEPA, 1997.

Policy and Procedures for the Filing, Review and Approval of Environmental Assessments

This document sets out the key policies and procedural requirements. It contains a brief policy statement on the purpose of environmental assessment and the goal of sustainable development and requires that environmental assessment be integrated with feasibility studies. It also defines the jurisdiction of the Federal and Provincial EPA's. It lists the responsibilities of the proponent and states the duties of responsible authorities. It provides schedules of projects that require either an IEE or EIA.

The Pakistan Environmental Protection Act, 1997 and Pakistan Environmental Protection Agency (Review of EIA/IEE) Regulations 2000 define Schedule (I &II) of projects falling under the requirement of EIA or IEE Study has, for environmental classification of the Project into Category A or B, taken account of the requirements of the Pakistan Environmental Protection Agency (Review of EIA /IEE) Regulations 2000 which define Schedules (I & II) as follows:

Category A: Projects are categorized A if they generate significant adverse environmental impacts that require a comprehensive management plan, or if the project is located within or passes through: a) Areas declared by the Government of Pakistan as environmentally

sensitive (National Parks / Sanctuaries / Game Reserve), b) Areas of international significance (e.g. protected wetland as designated by the RAMSAR Convention), or c) Areas designated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as cultural heritage sites.

Category B: A project falls in category 'B' if it is likely to have adverse environmental impacts, but of lesser degree or significance than those for Category 'A' and all the mitigation measures to handle the impact is manageable. Such types of projects need IEE Report including EMP.

Guidelines for the preparation and review of Environmental Reports NOVEMBER 1997/2000

These guidelines are descriptive documents regarding the format and content of IEE/EIA reports to be submitted to EPA for "No-Objection Certificate (NOC)/Environmental Approval (EA)". Following are the major areas which are covered by these guidelines:

- The IEE report (scope, alternatives, site selection, format of IEE report)
- Assessing impacts (identification, analysis and production, baseline data, significance) Mitigation and impact management (and preparing an environmental management plan)
- reporting (drafting style, main features, shortcomings, other forms of presentation)
- Review and decision making (role, steps, remedial options, checks and balances)
- Monitoring and auditing (systematic follow up, purpose, effective data management)
- Project Management (inter-disciplinary teams, programming and budgeting)

2.3 GUIDELINES FOR PUBLIC CONSULTATIONS

These guidelines deal with possible approaches to public consultation.(PC) and techniques for designing an effective program of consultation that reaches out to all major stakeholders and ensures the incorporation of their legitimate concerns in any impact assessment study. These guidelines cover:

- Consultation, involvement and participation of Stakeholders

- Techniques for public consultation (principles, levels of involvements, tools, building trust)
- Effective public consultation (planning, stages of EIA where consultation is appropriate)
- Consensus building and dispute resolution
- Facilitation of the involvement of the poor, women, building community and NGO capacity

2.4 NATIONAL ENVIRONMENTAL QUALITY STANDARDS (NEQS)

The National Environmental Quality Standards (NEQS) were first promulgated in 1993 and have been amended in 1995 and 2000.

The following standards are specified therein:

- Maximum allowable concentrations of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to inland waters, sewage treatment facilities, and the sea (three separate sets of numbers)
- Maximum allowable concentrations of pollutants (16 parameters) in gaseous emissions from industrial sources

2.5 SECTORAL GUIDELINES FOR ENVIRONMENTAL REPORTS

These guidelines identify the key environmental issues that need to be assessed as well as mitigation measures and project alternatives to be considered in the actual EIA. These guidelines include:

- Sector overview of the industry and the processes
- Potential impacts on the environment
- Mitigation measures
- Monitoring and reporting
- Management and training
- Checklist of likely environmental impacts and mitigation measures

Guidelines for Sensitive and Critical Areas

These guidelines identify sensitive and critical areas in Pakistan in relation to both the natural environment and the cultural aspects.

Forest Act, 1927

All India Forest Act, 1927 has been adopted by the Government of Pakistan, which has been implemented by the respective provinces. The law was enacted to conserve and protect the forest resources of the country for sustainable development. It lays down Rules and Regulations for exploitation of various categories of forests such as reserved, protected or unclassified. Further, the Act details the licensing method for timber cutting, grazing, hunting, etc. It also provides details of the magisterial powers of Forest Department officers and penalties for offences committed with regard to forest resources and products.

Other Relevant Laws

Some of the other relevant laws and legislations are listed below:

- Industrial Relations Ordinance, 1969
- Canal and Drainage Act, 1873
- The Explosives Act, 1884
- The Fire Wood and Charcoal (Restriction) Act, 1964
- Motor Vehicles Ordinance, 1965
- The West Pakistan Regulation and Control of Loudspeaker and
- Sound Amplifier Ordinance, 1965
- Agriculture Pesticides Ordinance, 1971
- The Antiquities Act, 1975

2.6 INTERNATIONAL REQUIREMENTS

The Asian Development Bank (ADB) Environmental Assessment Process

The Asian Development Bank (ADB) introduced EIA requirements in 1992. The ADB "Environmental Assessment Guidelines" were published in 2003. Since 1994, the ADB has approved a number of policies to guide its project and policy cycles as well as to ensure

accountability of borrowing countries, project proponents, and the Bank itself. The policies can be categorized into three: safeguards, sector and others.

The Safeguard Policies include the Environment (2002), Indigenous Peoples (1998) and Involuntary Resettlement (1995) policies. All three Safeguard Policies are due for revision and ADB intends to address emerging environmental and social challenges of development in its Developing Member Countries (DMC). Sector Policies include Energy (2000), Fisheries (1997), Forestry (1995), Water (2001), etc. Among the other important policies are the Public Communications Policy (2005) and ADB Accountability Mechanism (2004). According to Asian Development Bank, "Safeguard Policy Statement 2009":

ADB Environmental Policy: The ADB Environmental; Policy addresses five main challenges. According to the ADB, the Environmental Policy is based on its Poverty Reduction Strategy and Long-Term Strategic Framework. The area around the proposed project site has a sensitive environment comprising prime agricultural soils, human settlements, Cholistan desert biodiversity, mango orchards and cultural sites. Because of strict compliance with the environmental management system during the operational phase of the plant, all environmental aspects including stack gaseous emissions as well as particulate matter will remain well within the prescribed limits of the World Bank Standards. All effluents will be treated to meet the requirements of the World Bank Standards. Noise levels will also conform to the World Bank limiting values. Solid waste will also be disposed off in environmentally sustainable manner and necessary documentation will be maintained. Most likely, it will be done through a contractor, who will be provided due information about the wastes to be disposed by him. A record of the wastes will be maintained to tackle any eventuality likely to occur. The overall environmental aspects of the proposed project will be managed according to Environmental Management Plan and Environmental Management Monitoring Plan.

The EIA provides an assessment of the potential impacts of the project and compares them to feasible alternatives. Mitigation measures are provided to be incorporated during

construction and operational stages of the project in order to make the project environmentally friendly.

2.7 THE WORLD BANK ENVIRONMENTAL ASSESSMENT PROCESS

The principal international guidance utilized in assessing the significance of impacts from the proposed development, and for determining content and form of reporting from the World Bank was also utilized.

World Bank Operational Policies OP4.01 Environmental Assessment (January 1999):

This sets out the World Bank's policy on projects requiring an EIA and defines what the assessment is designed to achieve and what issues must be considered. It also sets out guidance for screening projects and identifies other World Bank guidance and policies that may be relevant.

World Bank – Pollution Prevention and Abatement Handbook (1998):

This handbook sets out the basic principles that are considered appropriate to evaluating and controlling pollution from any defined project. The handbook provides guidance on pollution management and sets out generic environmental standards for air, water and soil pollution. This handbook also provides sector guidance. Of most significance to this project is the guidance for Thermal Power: Guidelines for new plant (July the environmental assessment undertaken in this report also utilizes The World Bank guidelines presented in the "Pollution Prevention and Abatement Handbook" effective July 1998.

International Finance Corporation (IFC) Policy and Performance Standards on Social and Environmental Sustainability

The IFC applies the Performance Standards 1 to 8 to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. Environmental Assessment is the primary administrative tool to integrate environmental considerations into decision making of all types of development initiatives such as formulating policies, programs and project funding.

2.8 INSTITUTIONAL FRAMEWORK

The capability of regulatory institutions for environmental management largely, ensures the success of environmental assessment for ensuring that development projects are environmentally sound and sustainable. For decision-making and policy formulation relating to environmental and conservation issues, the institutional framework, as it exists in Pakistan, is described below:

Federal Government Institutions

The Ministry of Environment, Government of Pakistan, deals with the environment and wildlife issues at the federal level. Within the Ministry, the National Conservation Strategy (NCS) Unit, established in 1992, is responsible for overseeing the implementation of the Strategy.

Two organizations, the Pakistan Environmental Protection Council (PEPC) and the Pak-EPA, are primarily responsible for administering the provisions of PEPA, 1997. The PEPC oversees the functioning of the Pak-EPA. Its members include representatives of the government, industry, non-governmental organizations, and the private sector. The Pak-EPA is required to ensure compliance with the NEQS, establish monitoring and evaluation systems, and both identify the need to, as well as initiate legislation whenever necessary. It is thus the primary implementing agency in the hierarchy. The provincial EPAs are the provincial arms of the federal EPA, which is authorized to delegate powers to its provincial counterparts. One of the functions delegated by the Pak-EPA to the provincial EPAs is the review and approval of environmental assessment reports.

Provincial Government Institutions

Each province has its own Environmental Protection Ministry, with a Secretary Incharge. Under the Ministry, the Environmental Protection Agency (EPA) functions with the Director General as In charge to carry out all functions related to environmental issues. Environmental Protection Agency (EPA) is under the Minister. The provincial EPAs control planning and developments of the new development projects, and are responsible for the approval of the EIA and IEE. The Sindh Environmental Protection Agency (SEPA) is the

provincial agency responsible for the environmental protection and pollution control in the province of Sindh. Accordingly, the proposed project falls in the jurisdiction of SEPA. The IEE report for this project was prepared according to the Guidelines as approved by the Federal Ministry/Pak EPA and being followed by all the four provincial EPAs, is submitted to the Sindh EPA for Environmental Approval (EA)/ No Objection Certificate (NOC) for the project.

International and National Non-Governmental Organizations

International and national Non-Government Organizations (NGOs), such as the International Union for Conservation of Nature and Natural Resources (IUCN) and the World Wide Fund for Nature (WWF), have been active in Pakistan for some time. Both of these NGOs have worked closely with the governments at the federal as well as provincial levels and have positively contributed to the cause of environment. They have played significant roles with regard to the formulation of environmental and conservation policies. Another prominent NGO is the "Sustainable Development Policy Institute (SDPI)" which has also played a very significant role in upholding the cause of environmental protection in Pakistan. Environmental NGOs have been particularly active in the advocacy for promoting sustainable development approaches. Most of the government's environmental and conservation policies, even at the provincial and federal levels have been formulated in consultation with these leading NGOs, who have also been involved in drafting new legislation on conservation.

International Framework

For the assessment of the environmental impacts of the proposed project on air, water and noise according to the international legal framework, this report has also incorporated the "Pollution Prevention and Abatement Handbook" by the World Bank Group that became effective in July 1998. Within this handbook, different guidelines are mentioned for the purpose of assessing industrial facilities with respect to their environmental compliance. The guidelines for new thermal power plants are applicable for the preparation of this environmental impact assessment.

Baseline Environmental Status

3.1 SCOPE OF WORK

This section of the report gives description of the existing environmental studies within the project area, which constitutes the baseline for the study. Natural conditions are often critical when designing and constructing infrastructure works. The assessment of baseline studies of the appropriate environmental parameters, which may be affected by the project implementation, is a pre-requisite for any Environmental Assessment study. Monitoring surveys of the study area (project area) has been carried out once during study period. Field monitoring for meteorological conditions, ambient air quality, water quality, noise quality, etc. has been also carried out also once during auditing, which constitutes major portion of the baseline environmental studies.

In addition to these important parameters, certain aspects like land use, socioeconomic studies, geo-technical investigations etc. are covered during the study period. This information is based on secondary information sources and constitutes remaining part of the baseline environmental studies.

The Environmental auditing presents the existing environmental scenario and the results from the assessment and evaluation aspects emerging during the operation of the factory, its impact on existing baseline environmental and biological parameters and importantly on land use and socioeconomic parameters. The entire data has been collected through actual physical surveys and observations, literature surveys, interaction with locals, government agencies and departments. This chapter describes the baseline environment settings in the area and will throw light, its effect on day-to-day environment

3.2 BASELINE ENVIRONMENTAL STATUS

Baseline Environment

The baseline environmental qualities of various environmental components like air, noise, water, land, flora, fauna and socio-economic form an important and integral part of any environmental study. The baseline data forms the basis for predicting/assessing the environmental impacts of the proposed project. The baseline environmental quality is assessed through field surveys within the

impact zone as well as secondary data for various components of the environment, viz. air, noise, water, and land and socio-economic. The present report presents the data collected during the sampling period of three months. Various environmental components were monitored and samples were analyzed.

Environmental Settings

Studies were carried out in and around facility with respect to meteorology, flora, fauna, land, geology, hydrogeology and socioeconomics of the area. Further, the air quality, water quality, noise level and soil quality sampling and analysis was carried out. The air quality, water quality, noise level and soil quality in the study area is evaluated based on this physical sampling and analysis. The study team conducted site surveys and field experiments to gather the information on meteorology, air quality, and water quality, noise quality, and biological environment.

The various parameters studied during environmental survey at above locations are indicated in the following Table

Table 3.1: Environmental Settings

Sr. No	Parameters	
1	Meteorology	Temperature, Humidity, Rainfall, Wind Direction, Wind Speed etc.
2	Air	PM10, PM2.5, SOx, NOx, CO
3	Water	pH, COD, BOD, DO, etc.
4	Noise	Noise level
5	Land	Topography & Geology, Soil, Land use pattern.
6	Socio-economy	Demographical and socio-economic details

3.3 SITE LOCATION

The proposed Hytex co-firing power plant is situated at Tando Mohammad Khan Rd. SITE Area Hyderabad, Sindh. M/s. Hytex co-firing power plant has acquired 04 Acres of land in S.I.T.E Area, Hyderabad, Province of Sindh.

Its strategic decision to those this location as it is at junction of two major road links i.e. National Highways of Pakistan and Super high way, hence providing good reach links in all directions.

Baseline Data Generation

List of important physical environmental components and indicators of EBM are given in Table:

Table 3.2: List of Important Physical Environmental Components and Indicators of EBM

Environmental Component	Environmental Indicators
Climatic variables	Rainfall patterns – mean, mode, seasonality Temperature patterns Extreme events Climate change projections Prevailing wind - direction, speed, anomalies Relative humidity Stability conditions and mixing height, etc
Topography	Slope form Landform and terrain analysis Specific landform types, etc.
Drainage	Surface hydrology Natural drainage pattern and network Rainfall run off relationships Hydrogeology Groundwater characteristics – springs, etc.
Soil	Type and characteristics Porosity and permeability Sub-soil permeability Run-off rate Infiltration capacity Effective depth (inches/centimeters) Inherent fertility Suitability for method of sewage disposal, etc.
Geology	Underlying rock type, texture Surgical material

	Geologic structures (faults, shear zones, etc.) Geologic resources (minerals, etc.)
Water	Raw water availability Water quality Surface water (rivers, lakes, ponds, gullies) – quality, water depths, flooding areas, etc. Ground water – water table, local aquifer storage capacity, specific yield, specific retention, water level depths and fluctuations, etc. Coastal Floodplains Wastewater discharges Waste discharges, etc.
Air	Ambient Reparable Air shed importance Odor levels, etc.
Noise	Identifying sources of noise Noise due to traffic/transportation of vehicles Noise due to heavy equipment operations

3.4 INTRODUCTION

Location

The district takes its name from its headquarters town which is the second biggest city of Sindh Province. After the 1972 Census of Pakistan whole of Badin and Tando Bago Taluka, most of Matli Taluka and about half of Tando Muhammad Khan Taluka were taken out from the old Hyderabad district to form Badin district.

The district lies from 240-46' to 260-06' north latitudes and 680-16' to 680-59' east longitudes. It is bounded on the north by Nawabshah district, in the east by Sanghar and Tharparkar districts, in the south by Badin District and in the west by Thatta and Dadu districts. The total area of the district is 5,683 sq. km.

Demographic Characteristics

The Hyderabad District is spread over 5519 sq. Km., that is, 4.03% of the total geographical area of Sindh, but its share in total Population in 1998 accounted for 2840653 souls or 9.4% of the provincial population. It increased by 38% during 1981-98 periods in a span of 17 years at an average annual growth rate of 1.92%. In accordance with the land area of Hyderabad district i.e. 5683 sq. km. There is density of 515 persons per sq. km. as compared to 361 persons per sq. km. during 1981. Out of its total population, 1447957 persons or 51% are settled in urban areas and remaining 1392696 persons or 49% are located in rural areas. The sex ratio (male per 100 females) is worked out at 109; this ratio is also constituted of 109 males for rural and urban areas respectively.

According to 1998 population census, there are total 485967 households in Hyderabad district comprising of 2840653 persons thus giving an average size of six persons per household.

Micro-meteorology of the area

Pakistan's latitudinal and longitudinal extents and its Northern rim of lofty mountains are the two factors, which have a great bearing not only on temperature and rainfall patterns, but also on the general circulation of the wind on the Southern Asia.

Pakistan has distinct seasons marked by wide variation in temperature. The climate remains very salubrious from April to October but the winters get very cold due to snowfall. The coldest months are December, January and February. The hottest months are June and July. Rainfall in April and May is occasional but the heaviest rain is in July and August due to Monsoon season.

Winter

The winter season begins in the month of December and lasts till February. The Western Disturbance influences the winter season. The lowest temperature in the winter was 3.3 °C (37.9 °F), recorded on January 21, 1973. The highest temperature in winter was 38.2 °C (100.8 °F), recorded on February 16, 1993. Light to moderate showers occur in winter, which decreases the temperature further due to the Western Disturbance. The highest monthly rainfall in winter 106 millimeters (4.2 in) was recorded in February 2003. The fastest rainfall in 24 hours was also recorded on 18 February 2003: 105 millimeters (4.1 in) was recorded in less than 12 hours.

Spring

The spring season begins in March and lasts till April. Being a dry city, Hyderabad's spring season is almost not felt. The highest temperature of spring was 46 °C (115 °F), recorded on April 2, 2002, while the lowest 12 °C (54 °F) was recorded on March 7, 1994. Rains are rare in the spring season. The highest monthly rainfall 47.2 millimeters (1.86 in) was recorded in the month of March. The fastest rainfall in 24 hours 46.7 millimeters (1.84 in) was recorded on 2 April 1963.

Summer

The summer season begins in May and lasts till September. Summer is the longest season in Hyderabad. Monsoon rains also occur in this season; these rains last from June till September. Extremely high temperatures are recorded in the summer. Heavy rains are also occurring during the monsoon season. The highest temperature recorded in summer was 48.5 °C (119.3 °F), recorded on 7 June 1991, while the lowest 19 °C (66 °F) was recorded on May 4, 1989. The heaviest rainfall for Hyderabad also occurred in summer on September 12, 1962, when 250.7 mm of rain fell in 24 hours. The wettest month in Hyderabad is July. The highest monthly rainfall in summer 286 millimeters (11.3 in) was recorded in September 1962. In June 2010, Cyclone Phet's moisture caused heavy downpours in the city; a total of 76 millimeters (3.0 in) rainfall was recorded with 32 mph winds.

Autumn

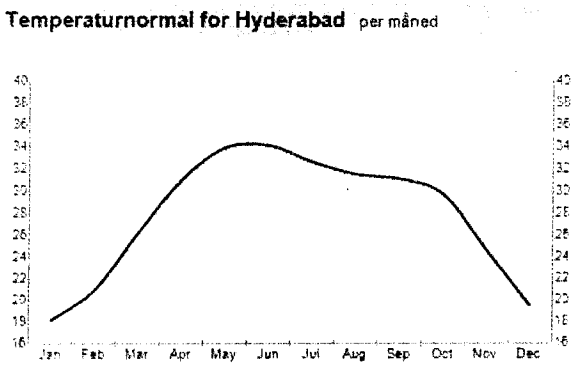
This season begins in October and ends in November. Hazy and dry weather is the main factor of autumn. The highest temperature 36.9 °C (98.4 °F) was recorded on October 8, 1987, and the lowest temperature was 6.7 °C (44.1 °F), recorded on 28 November 1966. Showers do occur in this season late in November from the Western Disturbances. The highest monthly rainfall in autumn was 103.3 mm in October 2004, while the fastest 24-hour rainfall in autumn 85.6 millimeters (3.37 in) was recorded on 3 October 2004. In October 2004, Cyclone Onil created havoc in the city, with 98 millimeters (3.9 in) rainfall, and caused the drainage system to collapse.

Humidity

Humidity is variable; it is highest on the whole at the end of August and much less in May when the air is uncomfortably dry. During summer, the wind blows in the south-west and in winter north-west direction. During the months of May and June, hot winds laden with dust blow constantly south-west direction. The district lies in the rain shadow area, and heavily laden south-west monsoon clouds rising from the Arabian Sea pass over this area without any showers. In winter, the district

gets some rain from the cyclonic winds, blowing from the Persian Gulf. The average daily relative humidity for April is around 40%.

Climate data for Hyderabad, Pakistan													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C (°F)				46.0 (114.8)	48.4 (119.1)	48.5 (119.3)	45.5 (113.9)						48.5 (119.3)
Average high °C (°F)													
Average low °C (°F)	11.1 (52.0)	13.8 (56.8)	18.6 (65.5)								17.1 (63.1)	12.8 (55.0)	21.1 (70.0)
Record low °C (°F)	3.3 (37.9)	4.0 (39.2)	9.0 (48.2)	12.0 (53.6)	19.0 (66.2)					15.0 (59.0)	6.0 (42.8)	3.0 (37.4)	3.3 (37.9)
Rainfall mm (inches)	1.5 (0.059)	5.4 (0.213)	4.8 (0.189)	6.0 (0.236)	3.6 (0.142)	9.6 (0.378)	53.0 (2.087)	62.3 (2.453)	19.4 (0.764)	4.2 (0.165)	1.9 (0.075)	2.5 (0.098)	174.2 (6.858)
Mean monthly sunshine hours	272.8	257.1	288.3	288.0	313.1	279.0	235.6	251.1	285.0	306.9	279.0	272.8	3,328.7



Wind

The average daily wind speed in April has been around 19 km/h, that's the equivalent to about 12 mph, or 11 knots. In recent years the maximum sustained wind speed has reached 83 km/h, that's the equivalent of around 52 mph, or 45 knots

Table 3.3: Average Wind Speed at 10m, 30m and 50m height in Hyderabad

Height	Data	Jan	Feb	Mar	April	May	June	Jul	Aug	Sep	Oct	Nov	Dec
10m	AWS	2.2	2.3	2.1	4.0	5.7	6.7	6.5	5.8	5.2	1.9	1.8	1.9
30m	AWS	3.6	3.6	3.6	5.6	7.8	8.8	8.8	7.5	3.2	6.9	3.2	3.2
50m	AWS	4.4	4.4	4.3	6.5	8.9	10.0	9.9	8.5	7.8	3.9	3.9	4.8

Courtesy: Pakistan Meteorological Department (PMD)

Figure-1 represents monthly average wind speed at 10, 20 & 50m height recorded Hyderabad stations in Sindh during three years

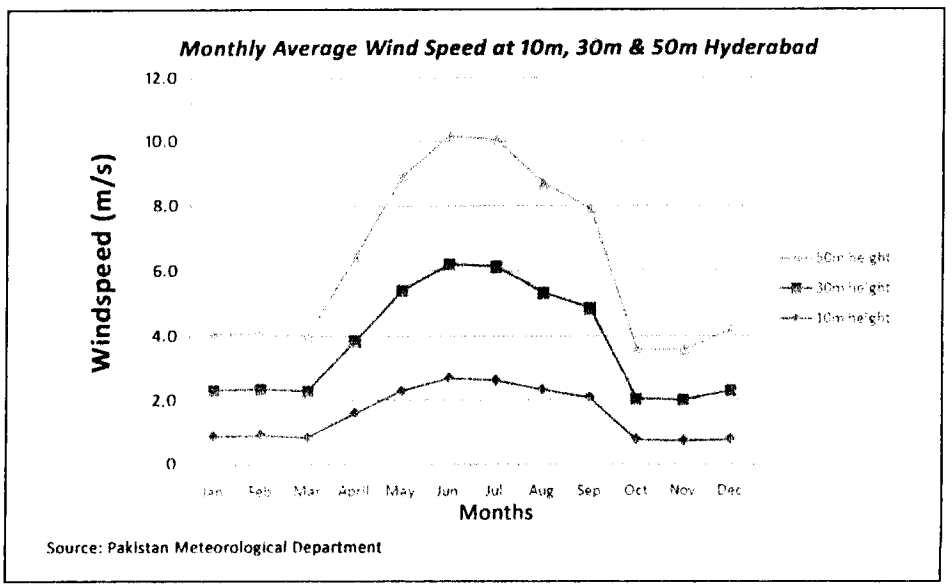
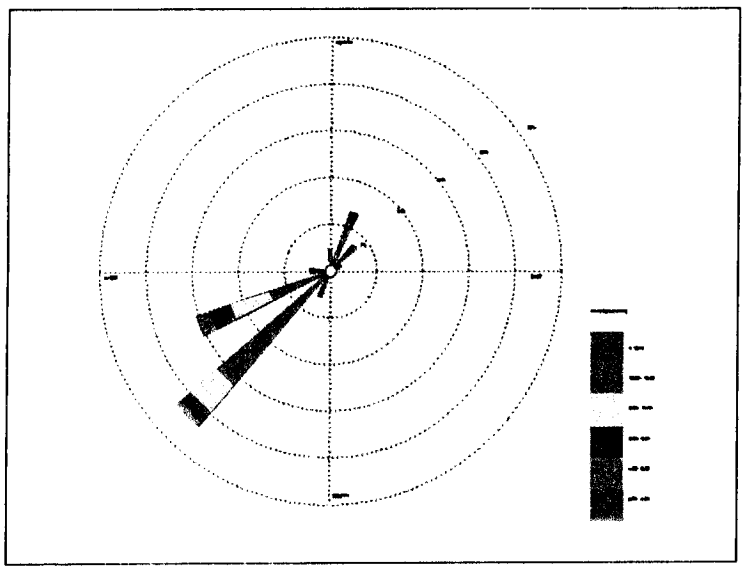


Table 3.4: Predominant Wind Direction at 12:00 & 0.00 UTS

Month	Morning	Speed Km/hr	Month	Morning	Speed Km/hr
January	N	0.8	July	SW	5.9
February	N	2.4	August	SW	4.3
March	NE	2.7	September	SW	0.5
April	SW	3.4	October	SW	0.9
May	SW	5.4	November	NE	0.8
June	SW	5.4	December	NE	0.2

Wind Roses

Most of the wind blows from south-southwest to west-southwest direction in Sindh region. However during summer season, a heat low exists over Baluchistan and adjoining areas. Its trough usually extended southeastward causing most frequent wind direction found west-northwest at Kati Bandar.



3.5 PHYSICAL ENVIRONMENT

Topography

Hyderabad district is a part of the Lower Indus plain. The Indus River flows along the western boundary of the district. It has a uniform land surface formed by the alluvial deposits of the Indus River. There are no mountains or hills in the district except some small hillocks locally known as Ganjo Takkar, meaning bald hillocks. They run parallel to the river Indus for about 22 kilometers south of Hyderabad city. The highest point in these hillocks is known as Gaho which is about 75 meters above sea level. There are also two small hillocks on the north of Tando Muhammad Khan town. They are named as Budhaka Takkar. The rest of the district is a fertile plain with an elevation of about 50 meters above sea level. There are some good reserves of forests in Hala Taluka along the river Indus.

Geology

The geology of Sindh is divisible in three main regions, the mountain ranges of Kirthar, Pab containing a chain of minor hills in the west and in east it is covered by the Thar Desert and part of Indian Platform where the main exposure is of Karonjhar Mountains, which is famous for Nagar Parkar Granite. In the north Sindh is enquired by rocks of Laki range extending to Suleiman range and its southern most part is encircled by the Arabian Sea. The rocks exposed in this area belong to upper Cretaceus which are recent in age. The sub-surface rocks are about 20,000 feet thick and belong to Cretaceous and Pre-Cretaceous periods. Mostly the rocks are of sedimentary origin of clastic and non-clastic nature and belong to marine, partly marine and fluviatile depositional environments. Basin wise Sindh lies in the lower Indus Basin and its main tectonic features are the platform and fore deep areas. Thick sequences of Pab sandstone of Upper Cretaceous, Ranikot Group (Khadro, Bara, Lakhra) of Paleocene, Laki, Tiyon, andKhirthar of Eocene age, Nari Formation of Oligocene, Gaj Formation of Lower to 3 Middle Miocene, Manchar of Upper Miocene to Pliocene, Dada Conglomerate of Pleistocene are present in various areas of Sindh. Limestone and sandstones are the most dominant sedimentary rocks in the area. Structurally Sindh generally contains gently folded anticlinal features trending in north-south direction. The major active faults in province are as under:

SURJANI FAULT: N-S Trending.

This fault located west of Larkana. It cuts Quaternary deposits. The maximum magnitude of the earthquake associated with the fault is of the order M=6.1 on Ritcher Scale.

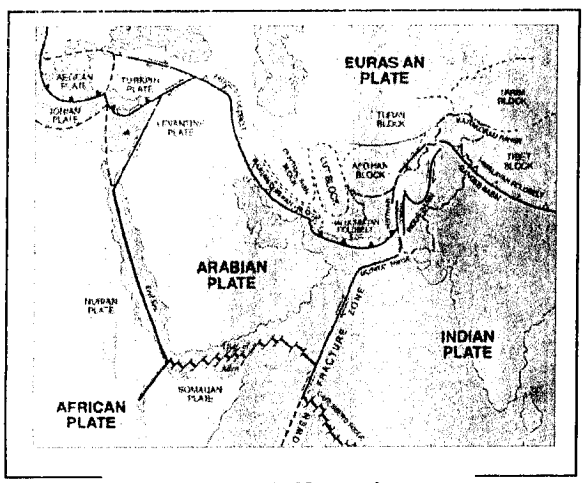
JHIMPIR FAULT: N-W Trending.

A number of epicenters are located on the fault. The fault has produced an earthquake of M=5.6 on Ritcher Scale.

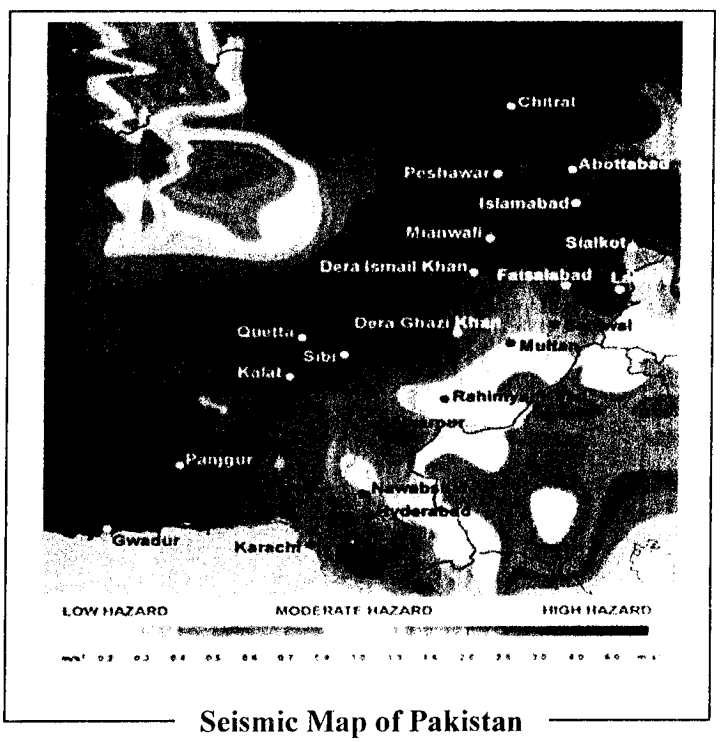
PAB FAULT: NN-W Trending.

It passes through the eastern part of Pab range. The maximum magnitude of the earthquake associated with fault is of the order M=7.0 on Ritcher Scale.

The fault has produced an earthquake of the order M=7.6 on Ritcher Scale. Recent studies have revealed that this fault traverses the Karachi Metropolitan Area.



Indo-Pak Eurasian Plates



Seismic Map of Pakistan

Soil

Particle size distributions show that most of the soil profiles had layers with clay, silty clay loam, and loam and clay loam textures. The main reasons for this particle size distribution pattern in the study area was possibly due to the nature of the parent material, the eluviations, alleviation and also may be some faunal activities It is evident that the soils of lower Indus Plain contain more clay. Similar

trend of soil texture also observed in salt-affected soils of Hyderabad district, the area adjacent to Badin district

At all depths, soil was slightly alkaline in reaction and showed pH range of 7.3 to 8.5. The alkaline pH was possibly due to the presence of high $CaCO_3$, as soils of the area were calcareous in nature the general pattern of $CaCO_3$ distribution in all profiles was irregular. The organic matter content was found to be < 1% in all opened pits, however, the upper layers contained more organic matter than the bottom most layers. Low organic matter content observed in these soils was possibly due to the lack of vegetation, except availability of some halophyte species such as Suede fruticosa, Alhaji mororum, etc. In general ~2% organic matter is considered necessary for productive soils but in the arid lands, it always remains <2%. Several other research workers have reported similar properties of salt-affected soils of Sindh province.

Compared to sub-soil and bottom layers, all soil profiles had high salinity problem in top most layers and show efflorescence of salts at surface. Surface efflorescence indicates the accumulation of soluble salts possibly brought by salty groundwater to the surface. Capillary rise of salty groundwater to the surface and accumulation of salts on surface has long been reported in arid soils. In some areas soil was found deeply saline and showed high ECe values throughout the layers; but the other profiles had high salinity in top layers only. Although, the concentrations of Na + and Cl- remained high in top layers, both Na+ and Cl- followed by SO_4^{2-} and HCO_3^- were found to be the dominant ions in almost all layers. Carbonates (CO_3^{2-}) generally remained absent in almost all soil samples, except only in those soil samples taken from bottom layers of Profile 2. The distribution of HCO3 generally remained uneven and irregular throughout the soil profiles.

Drainage

Indus is the primary source of water for the province which accounts for most of the agricultural production of Sindh. Its flowing length is about 2,880 Km and nearly a third of that (about 944 Km) traverses the province. Besides Indus there are numerous water resources which drain the hills and are known as Nais. The most important of them are NaiBran and Nai-Gaj. Manchar, Keenjhar and Haleji are among the major lakes of the province. The province is also rich with water bodies. There are 10 declared wetlands of international importance (Ramsar Sites) in Sindh. Most of these wetlands are directly fed by the major canals or their seepage and from rainfall. LBOD and RBOD crossing on the either sides of the province to drain out the agricultural effluents into Arabian Sea

from the districts of Sindh located on the left and right side of River Indus. Arabian Sea is the point of ultimate discharge of the whole province.

Surface Water

The only river flowing in the district Hyderabad is the Indus, which runs along the Western boundary of the district. It enters Sindh rushing through the gorge between Sukkur and Rohri in the lime stone rocks, and from here it flows comparatively calmly with two arms-known as Eastern Nara and Western Nara, and changes its direction to South-east, till it reaches Kotri. However, there is no river or stream in Hyderabad district.

All Urban localities in district Hyderabad are covered with water supply through a piped water system. Besides non-mechanised source of water supply like hand pumps/wells etc. are also used by the people. Hyderabad has at present 40 MGD water provided through various schemes while a number of twenty one water supply schemes have also been completed up to the year 1997-98 in other urban areas of the district Hyderabad.

Ground Water

The project area has plenty of water and the ground water table is high as it lies in Indus River Basin. In some areas the ground water table is low, especially in the Kirthar lime stone (middle Eocene) range, where water shortage is common and always a drought like situation is prevailed. Some parts of Sindh are facing severe water logging and salinity problem which has disturbed the ground water quality. Ground water extraction is very common practice for domestic and agriculture usage. Normally, the ground water depth varies from 40-150 ft at different locations in the project area

3.6 LAND UTILIZATION

The pattern of land use in a region determines crop production. Soil & climate play an important role in the management of cropping pattern of a region. Crop area used for food and cash crops can be taken as an index of the type of land system and the economic use for these crops. Land use data for latest five years are given in table No.1. The reported area in Hyderabad increased from just over 532.9 thousand hectares in 1993-94 to about 551.3 thousand hectares in 1997-98. However, not all of this area is cultivable. 28.8% was reported "uncultivable" though its share was 27.0% in 1993-94.

The share of cultivated area (in the area reported) decreased from 73.0% in 1993-94 to about 71.2% in 1997-98. It, however, is much higher as compared to over all Sindh reflecting higher cropping intensities.

The cropped area increased by about 4.7% likewise the cultivated area also slightly increased by 0.9% during the period of five years. A small part of the area about 1.7% is being used for grazing or forest and remaining land is lying unused due to unfavorable condition or lack of irrigation water.

It is noted that the pressure of total rural population on cultivated area has increased considerably since last many years. The ratio of cultivated area per person decreased from 0.21 in 1993-94 to 0.14 in 1997-98.

Existing manufacturing units (Medium & Large Scale)

The manufacturing establishments in district Hyderabad were reported as 95 units during census of manufacturing Industries (CMI) 1997-98. By comparing with the previous census that took place in 1990-91, under which 89 units were reported, it shows that 6 units have been increased. The leading manufacturing groups during 1997-98 were:

Cotton textile, Biscuits, Roller Flour Mills, Fabricated, Pharmaceutical, Cement, Glass industries, Cotton Ginning, Others

3.7 AGRICULTURE SECTOR

Pakistan's economy has undergone considerable diversification over the years yet the agriculture sector still constitutes its back-bone. With its present contribution to GDP at 24.87 percent, agriculture accounts for half of the total employed labor force and is the largest source of foreign exchange earnings while it serves as the base sector for the country's major industries like textile and sugar.

Forest

Sindh province having a population of about 29.99 million, occupies land area of 14.091 million ha equivalent to 34.81 million acres, out of which an area of 1.125million ha. (2.782 million acres) is under the control of Sindh Forest Department, which is 8% of the total area of the province. However, out of this total Riverine forests and Irrigated Plantations which are categorized as productive forests cover only 2.29% area. The details of both productive and protective categories of forests are as follows:

Table 3.5: Categories of Forests

Category	Type	Area (Million ha.)	% of total land area of Sindh
Productive Forests	Riverine Forests	0.241	1.71
	Irrigated Plantations	0.082	0.58
Protective Forests	Mangroves	0.345	2.45
	Rangelands	0.457	3.25
	Grand Total	1.125	8.00

Riverine Forests

Sindh Forest Department controls over an area of 241,198 hectares in the riverine tract of the province which are designated as riverine forests and locally known as Kacho forests. These forests are dependent on floodwater of river Indus and located along both the banks of the River Indus in Thatta, Hyderabad, Dadu, Larkana, Naushero Feroze, Nawabshah, Khairpur,Sukkur, Shikarpur, Ghotki and Kandhkot Districts. The rich alluvial soils support crops of Acacianilotica (Babul) with Populuseuphratica (bahan), Tamarixaphylla, Tamarixdioca(Lai) and Prosopiscineraria(Kandi). Riverine forests are the most productive forests of Sindh producing wood material for domesticandcommercial purposes Irrigated Plantations Irrigated forest plantations of Sindh Forest Department expand over an area of 82,195 ha. and have been declared as Reserved Forests. Details of irrigated plantations falling within the command area of various barrages are as under:-

Table 3.6: Barrage Zone and Area Irrigated

Sr .no.	Name of Barrage	Area (In Ha.)
1	Guddu Barrage Zone	18406
2	Sukkur Barrage Zone	34567
3	Kotri Barrage Zone	29222
	Total	82195

Main species growing there are Acacia nilotica (Babul), Eucalyptus spp. Talhi (Shisham), Simal and Conocarpus. Some development schemes were implemented since establishment of irrigation system. The continued diversion of Indus water in the absence of proper drainage system gave birth to the problems of water-logging and salinity which eventually lead to depressed crop yield and loss

of thousands of acres of cultivable land. The seepage from irrigation channels, agricultural fields, and flow of the historic Indus River has increased the ground water reservoir, which could not be drained due to flat topography of the area, low hydraulic gradient and finer textures of underlain aquifer. This resulted in accumulation of water in the aquifer body causing the rise of ground water table

Road Network

The District of Hyderabad is agriculturally and industrially one of the most important areas in the Province of Sindh and therefore requires adequate communication facilities. It is presently connected on all sides with the important places of the country both by roads and railways. The National Highway from Peshawar to Karachi passes through the area entering at about six miles north of Saeedabad town, running in a southerly direction along the river and leaving it at Kotri. Besides, there are some inter-district roads which connect Hyderabad with Mirpurkhas district in the East, Badin in the South, Sanghar in the North East, Nawabshah in the North, Dadu in North West and Thatta in the South West. Hyderabad is also connected with Karachi by the Super Highway which has reduced the distance between these two cities and provided a special link for the heavy traffic flow to and from Karachi. The road has been developed into 2 carriageways which has substantially reduced travel time. The internal communications in the area are also fairly good; there are a number of metalled roads which link the taluka and other important towns with each other and with the district headquarters. The Farm to Market Roads and link roads connect the taluka headquarters, agricultural farms and hinterland. The provision of farm to market roads is inadequate to cater the ever increasing requirement of metalled road and the farmer experience difficulties in bringing their agriculture produce to the towns.

Railways

The district is served with three railway lines of Pakistan Railways which connect Hyderabad with Karachi and Peshawar, Mirpurkhas and Badin Railway Station facilities are provided at all important places. A daily service of Pakistan International Airlines also operates through Hyderabad, connecting it with many important cities of Province and the Country.

3.8 BIOLOGICAL ENVIRONMENT

Flora

The type of soil i.e. sandy, loamy, water logged or saline, and the amount of moisture available mainly governs the vegetation species. Mostly, both sides of the road are covered with thick

vegetation that full fills its water requirements from the seepage water of farmlands, agricultural fields and canals of irrigation water network. In the water logged areas between, where Tamarix aphylla is the dominant species which is followed by Haloxylon stocksii as the second dominant species of saline areas.

The project site from Hyderabad bypass (Channel mori) to site area is dominated by Prosopis glandulosa and Salvadora oleoides along both sides of the road with small patches of Calotropis procera and Aerva javanica. At certain places, cultivated Nerium oleander and Carissa opaca are found. Similarly, thick plantation of Azadirachta indica, Albizia lebbek, Ficus religiosa, Ficus bengalensis, Moringa oleifera, Eucalyptus camaldulensis and Cordia myxa are frequently present on both sides of the existing road.

Although, at some places old tree plantations are limited to only one side or absent on both sides. For instance, 20 trees of Albizia lebbek (Shrin) and 36 trees of Azadirachta indica (Neem) are there, on single side of road, at a distance of about 25 kilometres from Hyderabad towards Tando Mohammed Khan, near Khather. 32 old trees of Ficus religiosa (Peepal) are near Goth Ameed Ali about 46 kilometres from Hyderabad towards Mirpurkhas, and more than a dozen of Acacia nilotica (Babur) trees, at a distance of about 27 kilometers from Hyderabad. Cultivated orchards are also important vegetative areas that have environmental as well as social concerns due to their commercial value.

The dominant trees in Hyderabad district are babul (Populus euphrafica), ber (Zizypuhs numularia) and several verities of Tamarix like plai (Tamarix gallica) and jhao (Tamarix diocia), talhi (Dalbergia sisoo), kri (Tamarix gallica), karir (Copparis aphylla).

Number of ornamental flowers found in farms, gardens and elsewhere in the area are rose (Rosa damascena), jasmine (Jasminum officinale), and tuberose (Polianthes tuberose) etc.

The area is mostly covered with weeds like Tamarix aphylla and Salvadora persica and exotic species like Prosopis glandulosa. Cutting/ clearance of these species has least concern. Old plantations of Azadirachta indica (Neem), Albizia lebbek (Shrin), Ficus religiosa (Peepal), Acacia nilotica (Babul), Cordia myxa (Lasura) and Ficus benghalensis (Borh) have special concerns.

As estimated of 111 plant species belonging to 41 families and 99 genera have been reported within the project area. The Annexure-4 provides the lpahabetical checklist of floral species with their local names, family name and life form. Poaceae family was found dominant with 18 vegetation species followed by Asteraceae having 7 species, Mimosaceae, Papilionaceae and Cyperaceae each having 5 while Malvaceae, Moraceae and Solanaceae each with 4 vegetation species from the project area. The Table 4.8 shows the number of floral species with dominant families. The Table 4.9 shows the life form status of all the 111 species that were observed during the field survey. The Table 4.10 shows percentage of each life form of the plant species in the project area.

Table 3.7: Number of species belonging to dominant families

No.	Family Name	No. of Species
1	Poaceae	18
2	Asteraceae	7
3	Mimosaceae	5
4	Papilionaceae	5
5	Cyperaceae	5
6	Malvaceae	4
7	Moraceae	4
8	Solanaceae	4

Table 3.8: Life form-wise breakdown of species

No.	Life Form	No. of Species
1	Herbs	39
2	Shrubs	19
3	Grasses	18
4	Trees	24
5	Climbers	3
6	Sedges	5
7	Creepers	3
	Total	111

Table 3.9: Percentage of life forms of the species in project area.

S. No	Life form	Percentage %
1	Herbs	35.1
2	Grasses	16.2
3	Trees	21.6
4	Shrubs	17.1
5	Sedges	4.5
6	Creepers	2.7
7	Climber	2.7

Important commercial crops of the project area are Saccharum officinale (Sugar cane), Brassica oleracea (Cabbage), Capsicum annum (Chilli), Gossypium sp. (Kapaas), Oryza sativa (Dhaan), Sorghum vulgare (Jawar) and Hibiscus esculentus (Bhindi). Similarly, fruit orchards comprising of Chiku, Mangoes of various varieties including Chounsa, Sindhri, Dosehri, Langrha, Fajri, Almas, Malda saroli and Tota parri. Jaman and Ber trees are also commonly cultivated along boundaries of fruit orchards.

Fauna

The vegetation along road sides supports bird's species including Ardeola grayii (Herons), Bubulcus ibis (Egrets), Centropus sinensis (Crows), Passer domesticus (Sparrows), Psittacula krameri (Parakeets), Pycnonotus cafer (Bulbuls), Acridotheres ginginianus (Myna), Pycnonotus cafer (Lapwing), and indian scoops owl (Otus bakkam-ovena) by providing breeding as well as shelter place. Shrubs of Salvador pleoides and Prosopis gladulosa provides ideal habitat to reptiles and mammals as well as for their survival. During field visit, it is estimated that of 27 species of birds, 18 species of mammals and 10 species of reptiles were present in the area. The detail of the faunal diversity of the project area is given in Annexure-Birds.

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. The birds found from the project area are Indian/Common Myna, House Crow, Red vented Bulbul, Collard Dove, House sparrow Little Brown Dove and Indian Pond Heron were found common. Migratory birds have also been reported as migrants during winter season. No migratory bird species was sighted perhaps due to off season. 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.

Mammals

There are 18 mammalian species which were recorded from the project area. The information was collected by direct sightings except of Indian Porcupine, Indian Grey Mangoos and Common Rats, while the rest of information was collected by witnessing the droppings of the concerned mammals, cages & paths and by interviewing the local people especially staff of Sindh Wildlife department deployed at Mirpurkhas and Hyderabad.

Reptiles

During the field surveys, 10 reptile species were recorded. Indian monitor, Agama and Garden lizard were recorded though direct sighting while others were reported by the local people and Wildlife Department staff.

Rare and endemic species

All species that are reported from the project area have a wide range of distribution in other ecological zones of country in general and Sindh province in particular. No endangered or threatened species have been reported from the project area during field visits.

Overview of Biomass & State of Co-firing / Combusting Technology

4.1 INTRODUCTION

With growing concern about global climate change and the environmental effects of energy generation, one energy source that has come to the forefront as an alternative is biomass. Biomass has achieved prominence as an alternative energy source because it is a renewable resource and because it is considered a carbon neutral energy source. Through photosynthesis plants capture carbon dioxide from the atmosphere and store it in biological molecules. If biomass is then combusted for power generation, these molecules break down and release carbon dioxide back into the atmosphere. When biomass grows back after being harvested for power generation the plant recaptures carbon dioxide from the atmosphere causing the entire process to have net zero emissions.

Although many biomass energy initiatives are focusing on converting biological molecules into liquid fuel for transport, biomass can also be converted to electric power. Converting biomass to power has the benefit of using a carbon neutral fuel to produce power, low capital costs if biomass is converted in existing power plants and can make use of varied biomass sources including cellulosic feed stocks that avoid the food versus fuel conflict.

Although biomass is considered a carbon neutral energy source, the fossil fuel inputs required cultivating, transport, process, and handle biomass as well as greenhouse gas emissions from other sources throughout these steps must be incorporated in to the carbon balance of bio-based fuel Generating renewable power from biomass and coal co-firing has many benefits aside from the decrease in GHG emissions. In contrast to bio-fuel production, the combustion of biomass to generate power can use a variety of feedstock's and biological molecules including herbaceous biomass and cellulosic feed-stocks. The variety of feedstock that can be used for power generation means that with careful selection of biomass fuel and its method of cultivation, biomass to power can avoid the food versus fuel debate, which has become a serious concern for bio-fuels as global food prices trend upwards. Because

biomass can be co-fired in a coal facility typically used for base load generation, biomass is a non-intermittent source of renewable electricity and avoids many of the strains placed on power systems by other renewable energy sources such as wind and solar.

Another benefit of biomass to power through combustion is that this technology has been used extensively around the world and can be rapidly deployed. The IEA Database of Biomass Co firing initiatives lists over 200 power plants worldwide that have co-fired or fired solely biomass fuels

4.2 BIOMASS AS RENEWABLE ENERGY SOURCE

Biomass is fuel that is developed from organic materials, a renewable and sustainable source of energy used to create electricity or other forms of power.

Some examples of materials that make up biomass fuels are:

- scrap lumber;
- forest debris;
- certain crops;
- manure; and
- Some types of waste residues.

With a constant supply of waste – from construction and demolition activities, to wood not used in papermaking, to municipal solid waste – green energy production can continue indefinitely.

Biomass is a renewable source of fuel to produce energy because:

- waste residues will always exist – in terms of scrap wood, mill residuals and forest resources; and
- Properly managed forests will always have more trees, and we will always have crops and the residual biological matter from those crops.

Re-Energy Holdings is an integrated waste fuel/biomass renewable energy company. Our facilities collect process and recycle items for use as fuel, as well as green energy facilities that create power from that waste.

Biomass has to be considered in the search for an alternative source of energy that is abundant in a wide-scale yet non-disruptive manner, since it is capable of being implemented at all levels of society. Although tree plantations have "considerable promise" in supplying an energy source, "actual commercial use of plantation-grown fuels for power generation is limited to a few isolated experiences." considering the United States ' current energy needs that would require an area of one million square miles. That's roughly one-third of the area of the 48 contiguous states. There is no way that plantations could be implemented at this scale, not to mention that soil exhaustion would eventually occur. Biomass cannot replace our current dependence on coal, oil, and natural gas, but it can complement other renewable such as solar and wind energy.

According to Flavin and Lenssen of the World watch Institute , "If the contribution of biomass to the world energy economy is to grow, technological innovations will be needed, so that biomass can be converted to usable energy in ways that are more efficient, less polluting, and at least as economical as today's practices." When we have enough government support and have allotted enough land for the continuous growth of energy crops for biomass-based energy, we may have a successful form of alternative energy. But "as long as worldwide prices of coal, oil and gas are relatively low, the establishment of plantations dedicated to supplying electric power or other higher forms of energy will occur only where financial subsidies or incentives exist or where other sources of energy are not available." Although it is currently utilized across the globe, biomass energy is clearly not capable of sustaining the world's energy needs on its own.

While the process to create electricity is similar whether using a biomass fuel or a fossil fuel, the equipment needed inside the plant is different. All of Re-Energy's power generation facilities have been outfitted — and new acquisitions are upgraded — to allow for the burning of biomass.

As with any electrical generation process, the facility needs a steady supply of fuel. In all cases, Re-Energy has suppliers to deliver a steady stream of biomass, and has engaged other

suppliers to ensure the facilities have what they need. In addition, we create fuel for other biomass consumers — as well as other products — at our recycling facilities.

While the process to create electricity is similar whether using a biomass fuel or a fossil fuel, the equipment needed inside the plant is different. All of Re-Energy's power generation facilities have been outfitted — and new acquisitions are upgraded — to allow for the burning of biomass.

As with any electrical generation process, the facility needs a steady supply of fuel. In all cases, Re-Energy has suppliers to deliver a steady stream of biomass, and has engaged other suppliers to ensure the facilities have what they need. In addition, we create fuel for other biomass consumers — as well as other products — at our recycling facilities.

4.3 CURRENT STATUS AND TRENDS OF BIOMASS ENERGY

Role of biomass as an energy resource in global, regional and local contexts

Due to the oil crisis in the 1970s there has been, and still are, growing concerns in many countries regarding security of energy supply, higher fossil fuel prices, environmental degradation, climate change and the sustainability of the energy system. These concerns have led to increased global attention in supporting the development of alternative energy based on renewable energy source. The potential of renewable energy to reduce dependency on conventional energy has been given serious consideration in recent years. Biomass is regarded as a renewable energy resource that offers potential opportunity to contribute to the global primary energy supply. The reason why biomass currently attracts attention is its renewability, potential for decentralized production and more importantly its carbon neutrality and hence its role in climate changes mitigation. Furthermore, it can be transformed into electricity, heat and power and used in forms which are more convenient.

Statistical data from the International Energy Agency (OECD/IEA, 2007) show that conventional energy resources, such as oil, are still the most important sources of energy followed by coal and gas, accounting for approximately 80 percent of Total Primary Energy Supply (TPES). The next important contributor is combustible renewable energy (CRE), which contributes around 10 percent of the world's TPES share (Figure, 4.1). This share is

different between developed and developing countries, where the share of CRE is higher in developing countries than in developed countries – 17 percent compared to 3 percent (Figure. 4.2). This figure reflects the high reliance of developing countries on CRE.

CRE, or traditional biomass energy, constitutes 80 percent of the total renewable energy consumed mainly in developing countries while other forms of modern renewable energy, such as hydro, geothermal, solar and wind power are consumed mainly in developed countries. Table 4 presents the percentage share of CRE to the total primary energy supply and also to the total renewable energy from different regions in the world. Asia and China (together with Africa) contribute the largest share compared to other regions

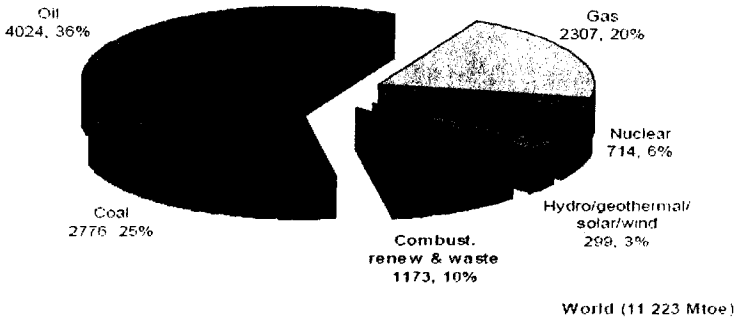


Figure 4.1: Share of CRE Sources to TPES in 2004

Source: OECD/IEA (2007)

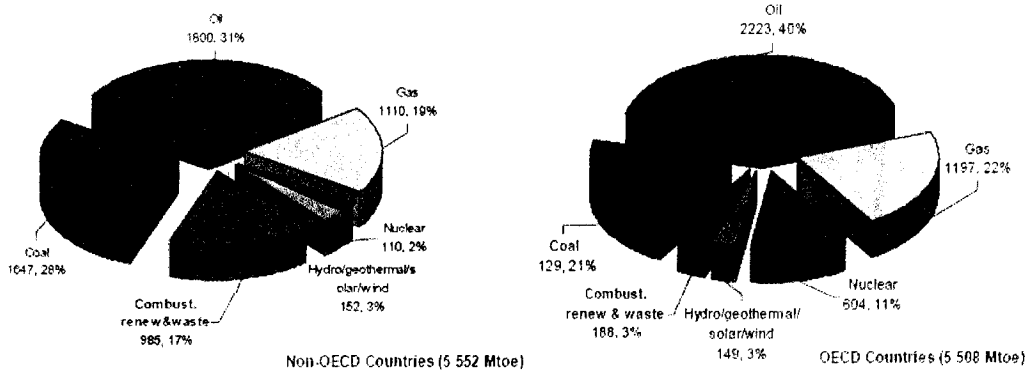


Figure 4.2: Comparison between developing (non-OECD) and developed (OECD) countries regarding the share of CRE in 2004

Source: OECD/IEA (2007).

If we compare the contribution within the Asia-Pacific region, CRE is an important energy resource in South Asia where 38 percent of the total primary energy supply comes from it (Figure 4.2). In Southeast Asia and China, the share of CRE is far less compared to South Asia (15 percent and 14 percent respectively).

Figure 4.3 also compares the production share of each category of CRE. Primary solid biomass contributes the major share compared to other types of CRE in the Asia-Pacific region, and also in the world in general. It accounted for almost 100 percent in South Asia and in Asia in general, whereas in Southeast Asia and China, besides solid biomass's place as the highest share, biogas contributes a small share to total production. In the Pacific region, even though solid biomass still contributes the major share (71.5 percent), it also produces more types of CRE, for example municipal and industrial waste, solar thermal and geothermal power as other important energy sources.

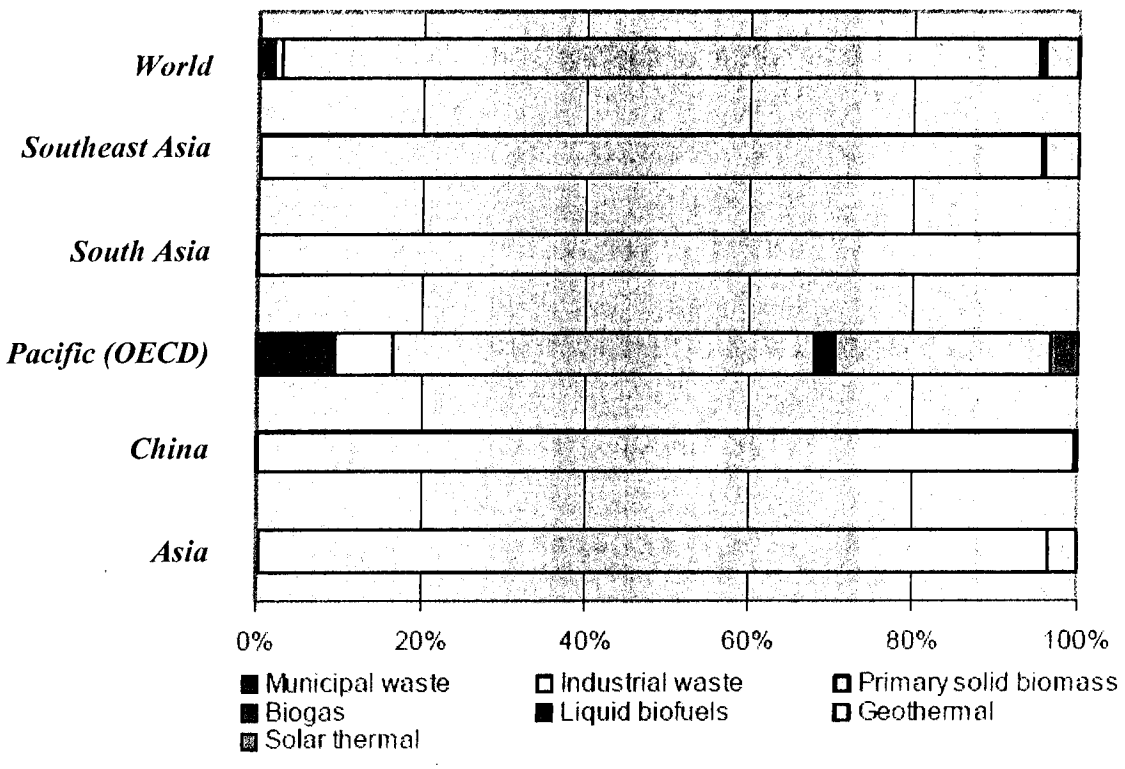


Figure 4.3: Share of Waste and primary solid biomass

Note: * Asia excluding China; **China includes People's Democratic of China and Hong Kong

Source: OECD/IEA (2007).

Biomass energy, particularly fuel wood, charcoal and agricultural waste, continues to play a significant role as energy resources. In 2002, out of 39 EJ (exajoules [1 billion joules]) of traditional biomass use, 21 EJ, or about 54 percent, was consumed in the form of wood fuel and the remainder came from manure. Traditional biomass remains a dominant energy source, especially for most rural households in developing countries, largely on account of its low cost and easy accessibility. High dependence on traditional biomass as a source of energy and limited access to commercial and modern fuels is a manifestation of poverty (IEA, 2002). Based on the current UN world population data (UN, 2007) in 2005, 51 percent of the world's population resides in rural areas; in the Asia-Pacific region, which shares 55 percent of the total world population, 67 percent or approximately 2.2 billion people live in rural areas. Although this region is on track to reach the MDG target of reducing poverty, about 641 million people are still living on less than US$1 per day, for example in Bangladesh, Cambodia and India (UNDP, 2007; UNESCAP, 2007).. For this segment of society, traditional biomass continues to play a vital role as the most important domestic energy source especially for cooking and space heating.

Biomass energy can make an important contribution if the resource is produced and used in a sustainable way and supported by a readily available market. Currently, the contribution of this energy source in the commercial market is low as it is being constrained by costs, uncompensated benefits and unsustainable biomass production. Therefore governing markets to maintain sustainable biomass production might increase its contribution in order to lessen dependence on fossil fuel enhance security of energy, increase local and regional employment opportunity and increase supply diversity which can improve options to meet specific users, particularly for rural areas in developing countries.

Increased awareness of the need to mitigate climate change has renewed attention on the role of biomass energy in both developing and developed countries. Biomass energy offers environmental and social benefits, for example its ability to be converted into electricity, heat, liquid and gaseous fuels that will benefit society. Biomass is a carbon neutral form of energy which offers a potential alternative source of energy as fossil fuel substitution that will contribute to mitigating climate change.

Energy is a vital element, as many views say it is "fuel for growth", to support socioeconomic development, ranging from the industrial, transportation as well as residential sectors. Energy use patterns largely depend on economic growth, demographic change and relative cost of availability of different energy sources. Population growth, rate of urbanization and increased prosperity are the main driving forces that lead to the changing pattern of energy use. In addition, environmental awareness and energy security have also become important elements that will drive the changing pattern. Energy security is related to the supply side, in particular oil and gas. Rising demand and resource depletion will have an adverse impact on economic development as well as the political situation (as the major exporting countries are situated in unstable regions, e.g. the Middle East) and social instabilities (for example rising and fluctuating prices) in many countries. The last two driving forces have triggered the growing interest in biomass energy in this past decade and this will impact energy consumption dynamics in the future.

The Asia-Pacific region is among the fastest-growing regions in the world, in terms of both population and economic growth. More than half of the world population resides in this region and although population growth rate is on the declining trend towards 2020, but in absolute terms, it is projected to increase about two-thirds, from 2.4 billion in 1980 to 4.2 billion in 2020. China, India Indonesia, Pakistan and Bangladesh are the major contributors to the increment. The Asia-Pacific region has attained high economic growth, Asian countries accounted for 5.3 percent per annum for this last 15 years (1990-20055), and for several developing countries the growth has been truly impressive, for example India and China with annual economic growth of about 6 and 10.1 percent respectively, higher than average annual growth in the world (3.4 percent) and developed countries (2.5 percent) for the same period. Increased income is always followed by increase in standard of living that in turn will draw people to move to more urbanized places. High rate of urbanization is mainly attributed to the countries with high population. In general the Asia-Pacific region is in an accelerating stage of urbanization, with Southeast Asia having the highest growth rate, followed by East Asia and South Asia. However, considering the overall situation will vary amongst countries with various levels of economic performance and demographic changes,

hence for the purpose of exploring the scenarios, countries will be clustered into three groups, as described in Table 6.

4.4 GLOBAL BIOMASS POWER MARKET TRENDS

Current Installed Capacity and Generation

In 2010 the global installed capacity of biomass power generation plants was between 54 GW and 62 GW. The range suggests that power generation from biomass represents 1.2% of total global power generation capacity and provides around 1.4% to 1.5% of global electricity production Europe, North America and South America account for around 85% of total installed capacity globally.

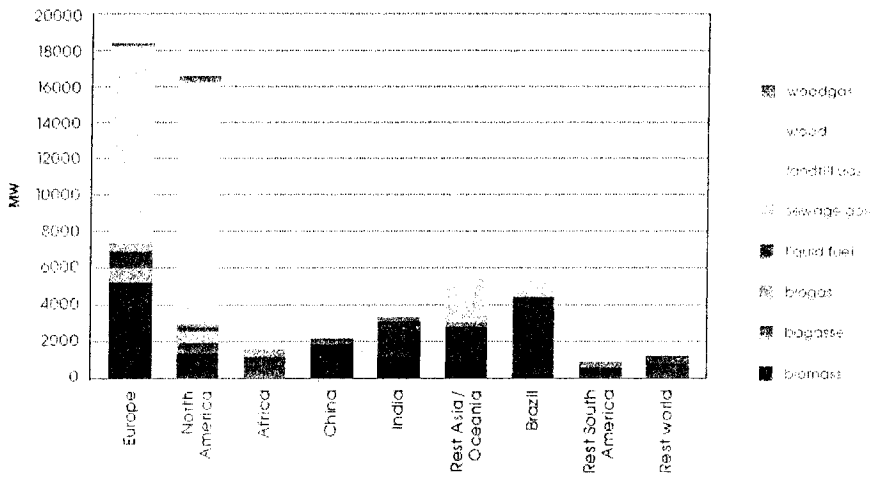


Figure 4.4: Global Grid-Connected Biomass capacity in 2010 in feedstock and country/region (MW)

In Europe, 61% of total European installed capacity using solid biomass (excluding wood chips) is in England, Scotland and Sweden. Wood-fired biomass power capacity is concentrated in Finland, Sweden England and Germany. Together these four countries account for 67.5% of European wood-fired biomass power generation capacity. Landfill gas capacity is concentrated in England with 45% of the European total, while biogas capacity is concentrated in Germany with 37% of total European capacity. In North America wood accounts for 65% of total installed capacity and landfill gas 16%. In South America, Brazil is the largest producer of biomass electricity as a result of the extensive use of bagasse for co-generation in the sugar and ethanol industry. Despite the large biomass resources in

developing and emerging economies, the relative contribution of biomass is small, with the majority of biomass capacity located in Europe and North America. The Around 84% of total installed biomass power generation today is based on combustion with steam turbines for power generation, with around half of this capacity also producing heat (combined heat and power) for industry or the residential and service sectors.

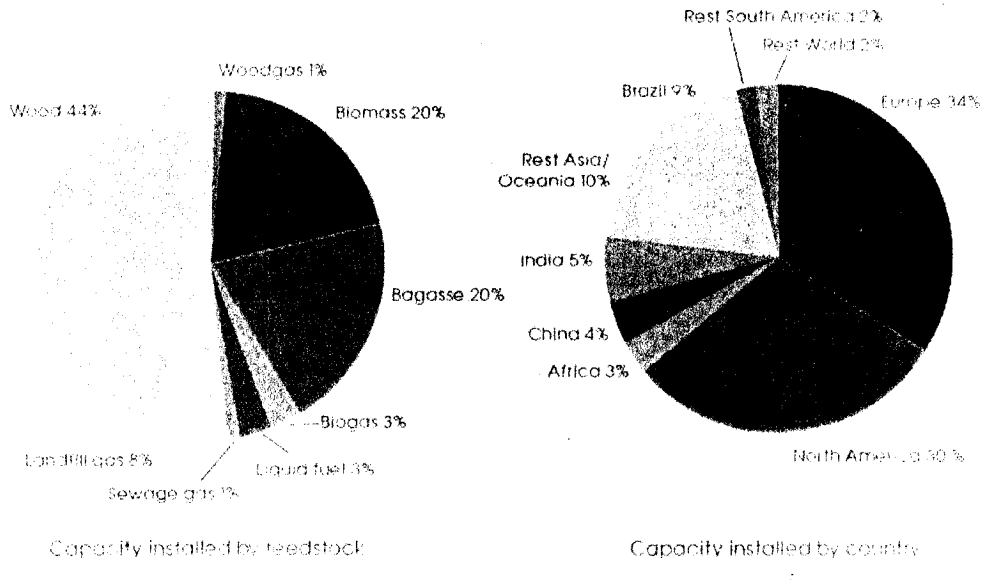


Figure 4.5: Share of Global Installed biomass capacity in 2010 by feedstock and country/region

The co-firing of thermal plants with biomass is becoming increasingly common. By the end of 2011, around 45 GW of thermal capacity was being co fired with biomass to some extent in Europe. In North America, around 10 GW of capacity is co-firing with biomass (IEA Bio-energy, 2012 and Platts, 2011).

4.5 BIOMASS ENERGY IN ASIAN DEVELOPING COUNTRIES

Biomass remains the primary energy source in the developing countries in Asia. Share of biomass in energy varies - from a very high over three quarters in percent in Nepal Laos, Bhutan, Cambodia, Sri Lanka and Myanmar; nearly half in Vietnam, Pakistan and Philippines; nearly a third in India and Indonesia, to a low 10 percent in China and 7 percent in Malaysia . In the wake of rapid industrialization and marketization during past two decades, the higher penetration of commercial fossil fuels in most Asian developing nations has caused decline

in the share of biomass energy. The absolute consumption of biomass energy has however risen unabatedly during past two decades, growing at an annual rate of over 2percent. Various factors like rising population and shortages or un-affordability of commercial fuels in rural and traditional sectors have sustained the growing biomass use. The increasing pressure on existing forests has already lead to considerable deforestation. Despite policy interventions by many Asian governments, the deforestation in tropics far exceeded a forestation (by a ratio of 8.5:1) during the 1980's. The deforestation and land degradation has made tropical Asian forests the net emitters of atmospheric CO_2. The sustainable growth of biomass energy in Asia therefore would require augmenting existing biomass resources with modern plantations and energy crops and by introducing efficient biomass energy conversion technologies. Lately, many Asian countries have initiated such programs.

Modernization of Biomass Energy in Asia

Modernization in biomass energy use in Asia has happened in the last two decades along three routes.

i) improvement of technologies in traditional biomass applications such as for cooking and rural industries,

ii) process development for conversion of raw biomass to superior fuels (such as liquid fuels, gas and briquettes), and

iii) Penetration of biomass based electricity generation technologies. These developments have opened new avenues for biomass energy in several Asian nations including China, India, Thailand, Indonesia, Philippines, and Malaysia.

In addition to the electricity generation, disposal of biological waste cuts down on the levels of expulsion of carbon and methane into the atmosphere. Thus, it maintains an ecological balance of carbon present in the environment

4.6 OVERVIEW OF THE STATE OF TECHNOLOGY

Biomass refers to any biologically sourced feedstock that ultimately derives from a plant source. Through photosynthesis, green plants convert solar energy to chemical energy

stored in the bonds of biological molecules. This energy is released through various chemical pathways and can be used for everyday plant functions. Because plants originally sequester the carbon in biomass from the atmosphere, biomass is considered a carbon neutral energy source. Chemical energy in the biological molecules of plants can be released through combustion or other thermo-chemical processes for use in power generation. Biological processing to convert biomass to liquid fuels is another, more common, route for converting biomass to energy. Nonetheless, this thesis will focus on the biomass to power route through combustion in a boiler. Biomass combustion for power generation is a mature technology that has the potential to decrease GHG emissions from electricity generation in the near term. In addition, if a carbon capture and sequestration unit is added to a biomass power plant, then part of the carbon dioxide captured from the air by the biomass will be sequestered and possibly lead to negative carbon emissions. Although biomass has the potential to contribute significantly to low carbon power generation, implementation of the technology has not been widespread. Worldwide dedicated firing and co-firing of biomass has been practiced at over 200 power plants with capacities as high as 4000 MW.

4.7 STATUS OF BIOMASS ENERGY

Biomass materials are used since millennia for meeting myriad human needs including energy. Main sources of biomass energy are trees, crops and animal waste. Until the middle of 19th century, biomass dominated the global energy supply with a seventy percent share. Among the biomass energy sources, wood fuels are the most prominent. With rapid increase in fossil fuel use, the share of biomass in total energy declined steadily through substitution by coal in the nineteenth century and later by refined oil and gas during the twentieth century. Despite its declining share in energy, global consumption of wood energy has continued to grow. During 1974 to 1994, global wood consumption for energy grew annually by over 2 percent rate. Presently, the biomass sources contribute 14% of global energy and 38% of energy in developing countries. Globally, the energy content of biomass residues in agriculture based industries annually is estimated at 56 exa-joules, nearly a quarter of global primary energy use of 230 exa-joules

Biomass is one of the most plentiful and well-utilized sources of renewable energy in the world. Broadly speaking, it is organic material produced by the photosynthesis of light. The chemical materials (organic compounds of carbons) are stored and can then be used to generate energy. The most common biomass used for energy is wood from trees. Wood has been used by humans for producing energy for heating and cooking for a very long time.

Biomass has been converted by partial-pyrolisis to charcoal for thousands of years. Charcoal, in turn has been used for forging metals and for light industry for millennia. Both wood and charcoal formed part of the backbone of the early Industrial Revolution (much northern England, Scotland and Ireland were deforested to produce charcoal) prior to the discovery of coal for energy.

Wood is still used extensively for energy in both household situations, and in industry, particularly in the timber, paper and pulp and other forestry-related industries. Woody biomass accounts for over 10% of the primary energy consumed in Austria, and it accounts for much more of the primary energy consumed in most of the developing world, primarily for cooking and space heating.

It is used to raise steam, which, in turn, is used as a by-product to generate electricity. Considerable research and development work is currently underway to develop smaller gasifies that would produce electricity on a small-scale. For the moment, however, biomass is used for off-grid electricity generation, but almost exclusively on a large-, industrial-scale.

Bio-energy can be defined as energy obtained from biological and renewable sources (biomass); bio-energy may be derived in the form of heat or transformed into electricity for distribution. Biomass also can be transformed into bio-fuels, which are portable feedstock for use in the generation of bio-energy. Bio-fuels are defined as feedstock intended for the production of bio-energy, produced directly or indirectly from biomass. Bio-fuels can be in solid form (fuel wood, charcoal, wood pellets, briquettes etc.) or liquid (bio-ethanol, biodiesel).

Feedstock

Biomass is the organic material of recently living plants from trees, grasses and agricultural crops. Biomass feed stocks are very heterogeneous and the chemical composition is highly dependent on the plant species. This highly heterogonous nature of biomass can be a problem since, although some combustion technologies can accept a wide range of biomass feed stocks, others require much more homogenous feed stocks in order to operate.

Table 4.1: Heat Content of Various Biomass Fuels (Dry Basis)

	Higher heating value mJ/kg	Lower heating value mJ/kg
Agricultural Residues		
Corn stalks/Stover	17.6 – 20.5	16.8 – 18.1
Sugarcane bagasse	15.6 – 19.4	15 – 17.9
Wheat straw	16.1 – 18.9	15.1 – 17.7
Hulls, shells, pruning's	15.8 – 20.5	----
Herbaceous Crops		
Miscanthus	18.1 – 19.6	17.8 – 18.1
Switch grass	18.0 – 19.1	16.8 – 18.6
Other grasses	18.2 – 18.6	16.9 – 17.3
Bamboo	19.0 – 19.8	----
Woody Crops		
Black locust	19.5 – 19.9	18.5
Eucalyptus	19.0 – 19.6	18.0
Hybrid poplar	19.0 – 19.7	17.7
Douglas fir	19.5 – 21.4	-----
Poplar	18.8 – 22.4 maple wood	-----
maple wood	18.5 – 19.9	-----
Pine	19.2 – 22.4	-----
Willow	18.6 – 20.2	16.7 – 18.4
Forest Residues		

Hardwood wood	18.6 – 20.7	----
Softwood wood	18.6 – 21.1	17.5 – 20.8
Urban Residues		
MSW	13.1 – 19.9	12.0 – 18.6
RDF	15.5 – 19.9	14.3 – 18.6
Newspaper	19.7 – 22.2	18.4 – 20.7
Corrugated paper	17.3 – 18.5	17.2
Waxed cartons	27.3	25.6

Sources: US DOE, 2012; JENKINS, 1993; JENKINS, et al., 1998; TILMAN, 1978; BUSH N ELL, 1989; ECN, 2011; & CIOLKOSZ, 201 0.

Biomass' chemical composition is comprised of generally high (but variable) moisture content, a fibrous structure, which is comprised of lignin, carbohydrates or sugars and ash. Ligno-cellulose is the botanical term used to describe biomass from woody or fibrous plant materials. It is a combination of lignin, cellulose and hemi -cellulose polymers interlinked in a heterogonous matrix. The chemical composition of the biomass feedstock influences its energy density. Table 4.1 presents the energy density on a dry basis of different feed stocks. Hard woods tend to have higher energy densities but tend to grow more slowly. The main characteristics that affect the quality of biomass feedstock are moisture content, ash content and particle size, and density.

Carbon Balance for Biomass Feedstock

Although biomass itself is carbon neutral, the process of cultivating, harvesting and transporting biomass incurs significant carbon emissions. These fuel-cycle emissions, though, vary depending on the type of biomass analyzed, its source, and the practices used during production. In addition, the impact on land use change from dedicated energy crops (those produced solely to be converted to energy) on GHG emissions is also a major concern

Moisture content

The moisture of biomass can vary from 10% to 60%, or even more in the case of some organic wastes. Stoker and CFB boilers can accept higher moisture content fuel than gasifiers. In anaerobic digestion, several options are available, including high solids dry, high solids-wet or low solids-wet. In the case of a low solids-wet configuration, such as with

manure slurry, the solids content can be 15% or less.15 The key problem with a high moisture content, even when it is destined for anaerobic digestion, is that it reduces the energy value of the feedstock. This increases transportation costs and the fuel cost on an energy basis, as more wet material is required to be transported and provide the equivalent net energy content for combustion.

Improving the energy density of the feed stock helps to reduce transportation costs and can improve combustion efficiency. The principal means of achieving this is through drying by natural or accelerated means. Other options include torrefaction, pelletising or briquetting, and conversion to charcoal. The trade-off is that these processes increase feedstock prices, and the energy balance decreases significantly due to the energy consumption used for the pre-treatment of the biomass. However, although his increases the costs per ton of feedstock, it can sometimes reduce the price of the feedstock per unit of energy.

Ash content and slagging

An important consideration for feed stocks is the ash content, as ash can form deposits inside the combustion chamber and gasifier, called "slagging" and "fouling", which can impair performance and crop residues typically have higher amounts of ash than wood. Slagging occurs in the boiler sections that are directly exposed to flame irradiation. Slagging deposits consist of an inner powdery layer followed by deposits of silicate and alkali compounds. Fouling deposits form in the convective parts of the boiler, mainly due to condensation of volatile compounds that have been vaporized in previous boiler sections and are loosely bonded .Slagging and fouling can be minimized by keeping the combustion temperature low enough to prevent the ash from fusing. Alternately, high-temperature combustion could be designed to encourage the formation of clinkers (hardened ash), which could then be more easily disposed of. Some types of biomass have problems with the ash generated. This is the case for rice husks that need special combustion system due to the silica content of the husks.

Feedstock size

The size and density of the biomass is also important because they affect the rate of heating and drying during the process. Large particles heat up more slowly than smaller ones,

resulting enlarger particles producing more char and less tar. In fixed bed gasifiers, fine-grained and/or fluffy feedstock may cause flow problems in the bunker section, resulting in an unacceptable pressure drop in the reduction zone and a high proportion of dust particles in the gas. In down draft gasifiers, the large pressure drop can also reduce the gas load, resulting in low temperatures and higher tar production. The type of handling equipment is also determined by the size, shape, density, moisture content and composition of the fuel. The wrong design will have an impact on the efficiency of the combustion/gasification process and may cause damage to the handling system.

4.8 CO-FIRING

During the Past 10 Years, Co-firing has emerged from a Niche Application to Broader Commercial Competitiveness. This growth is due in part to an increasing body of experience that is producing key information on plant performance. In addition, new incentives are highlighting the environmental benefits of co-firing and the advantages of the technology in a deregulated utility environment.

Biomass co-firing has an enormous potential to reduce CO_2 emissions as biomass can replace between 20-50% of coal. However, the net reduction of CO_2 emissions and other pollutants depend to a high degree on biomass feedstock's origin and supply chain. In addition, a high percentage of biomass co-firing may reduce efficiency and power output. Nevertheless, the substitution of only 10% of coal in the currently installed coal-fired electrical capacity would result in about 150 GW biomass power capacities, which is 2.5 times higher than the current globally installed biomass power capacity.

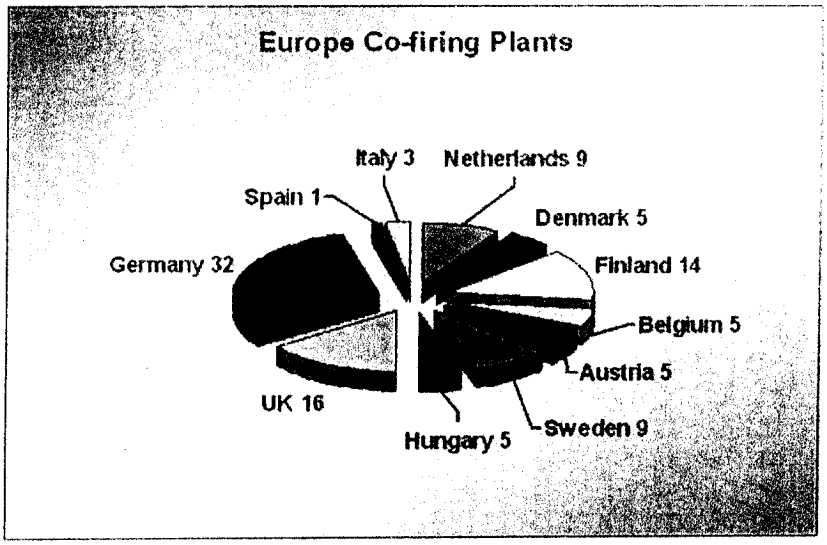


Figure 4.6: Number of Co-firing plants in Europe

Biomass co-firing can be considered as a transition option towards a completely carbon-free power sector. Several European countries, in addition to the United States, already offer policy incentives or have mandatory regulations to increase renewable share in the electricity sector. This supports the use of biomass co-firing and, as a result, most biomass co-firing projects take place in these countries. The Clean Development Mechanism (CDM) recognizes biomass co-firing as a way to reduce CO_2emissions in developing countries. However, to exploit the co-firing potential without adverse environmental impact, urgent measures and technology preparation are needed in emerging economies (e.g. India and China), where coal-fired power capacity is rapidly growing and large sources of biomass are available. The indicators developed by international organizations to measure the sustainability of bio-energy (including protection of soil and water resources, bio-diversity, land allocation and tenure, and food prices) need to be integrated into the relevant policy measures

Origin of co-firing and meaning according to present technology framework

Co-firing (also referred to as co-firing or co-combustion) is the combustion of two different fuels in the same combustion system. Fuels can be solid fuels, liquid fuels or gaseous, and its source either fossil or renewable. Therefore, use of heavy fuel oil assisting coal power stations may technically be considered co-firing. However the term co-firing is used in the

present technological framework to designate combined combustion of two (or more) fuels sustained in time, as a normal daily practice.

The interest in co-firing and the use of this term sprung up in the 80's in the U.S. and Europe, and referred specifically to the use of waste solid residues (paper, plastic, solvents, tars, etc.) or biomass in coal power stations that were designed only for the combustion of coal, and attempted, because of the existence of those new opportunity fuels, to carry out a combined combustion in order to increase benefit margins. This interest in co-firing has grown in the last decade mainly due to increasing social concern about global warming and greenhouse gas (GHG) emissions. The consequences of this concern are new policies on energy and the environment aimed at reducing emissions. Co-firing is regarded as a great opportunity for replacing coal (solid fossil fuel) used for power generation with renewable fuels (biomass) with lower costs and a direct decrease in greenhouse gas emissions. During the last few decades research has provided very diverse solutions for co-firing biomass in coal power stations with a limited impact in efficiency, operation and lifespan.

In the present context the definition of co-firing could be: The use together of two (or more) fuels, the primary being fossil and the secondary from another source (renewable or residual), in a boiler originally designed for fossil fuel, either using the original combustion system or additional devices.

4.9 CO-FIRING TECHNOLOGY

Co-firing with coal involves the combustion of coal and other fuels in the same boiler. The most economical co-firing fuels are wood residues from urban demolition, mills and manufacturing, including sawdust, bark, tree trimmings, spent pallets and utility poles.

Since the late 1980s, a number of full-scale co-firing tests have been completed successfully in the full range of coal boiler types--cyclones, pulverized coal (PC) boilers, stokers, and bubbling and circulating fluidized beds--and in boilers having power capacities ranging from 15 MW to more than 500 MW. Supporting these demonstrations have been laboratory and pilot tests of fuel handling and storage, fuel chemistry and emissions production.

Results have shown that cyclone boilers are particularly suitable for co-firing because they require minimal modifications for feeding and mixing the biomass fuel with coal, because they accept crushed (not pulverized) coal, and because they run hot in a slagging mode.

One of the key results to date has been identification and optimization of the most significant factors affecting combustion efficiency. These factors are particle size, particle dryness and fuel chemistry. "For pulverized coal boilers, it was found that biomass fuel feed-stocks should be reduced to about a quarter of an inch or smaller particle size, with moisture levels under 30 percent. Cyclones can burn slightly larger wood particles, up to a half inch, and feed stocks with up to 50 percent moisture have been successfully burned."

Tests also show that losses in boiler efficiency due to co-firing are small (0.3-0.6 points out of 85-88 percentage points) and are caused by moisture in the biomass fuel.

Advantages of co-firing

Use of biomass in co-firing incorporate additional environmental, socio-economic and strategy advantages regarding the use of biomass in dedicated biomass plants. In case of waste residues there are no additional benefits, however the combustion of waste may change the emissions regulations to satisfy more strict regulations. For example, limits in emissions from environmental regulations for large scale combustion facilities are more permissive than regulations for incineration plants. Except for the previous drawback related to waste co-firing, the following advantages are common for waste and biomass co-firing:

- *Specific investment (per unit of installed power):* reduced in comparison with conventional biomass facilities since plant using fossil fuel already exists and only diverse modifications are required
- *Power generation with better efficiency:* generally biomass power plants produce electricity with relative low efficiency (18 to 22%) compared with the huge coal units (32 to 38%) with optimized cycles given the economy of scale.

- *Flexible operation:* original plant can operate still at 100% load with fossil fuel. Co-firing facility is less sensitive to seasonality in biomass production and to biomass availability and price
- *Carrot for development of biomass markets:* diverse European countries have proven the promotion of co-firing is a key for the development of biomass markets as well as for the creation of expertise on biomass handling and combustion

Co-firing of blends

- In the combustion applications, biomass has been fired directly either alone (as a sole source fuel) or along with a primary fuel (co-firing). These include on-site gasification, fluidized bed combustion and circulating fluidized bed combustion. Some of the biomass technologies have met with limited technical success. The limitations were primarily due to relying on biomass as the sole source of fuel, despite the highly variable properties of biomass. The high moisture and ash contents in biomass fuels can cause ignition and combustion problems. The melting point of the dissolved ash can also is low which causes fouling and slagging problems. Because of the lower heating values of biomass accompanied by flame stability problems, co-firing currently holds more appeal than any of the sole source technologies including more advanced conversion options such as integrated gasification combined cycles. It is anticipated that blending biomass with higher-quality coal will reduce flame stability problems, as well as minimize corrosion effects. The co-firing approach will also have high potential for commercialization. The synergetic effects of blending coal and biomass may also lead to reductions in other pollutant emissions. For example, HC are known to react with NOx and produce molecular N_2. By injecting coal beyond the combustion zone as a re-burn fuel, the HC released from volatiles can be used to reduce NOx. The higher the VM content the larger the reduction in NOx. While coal contains 40–50% VM, biomass contain up to 80% VM on a DAF basis. Hence, biomass has the potential to be a very effective re-burns fuel when coal is used as the primary fuel. Another possible advantage of biomass blend combustion stems from the potential catalytic reduction

of NOx by NH_3 found in the biomass. For example, NH_3 is naturally present in animal waste.

Classes of co-firing

In order to present a discussion of coal biomass blend combustion, three classes of co-firing are defined. The class of co-firing depends upon the feeding method used for the coal and biomass fuels.

- Separate feed lines and separate burners for coal and biomass fuels.
- Separate feed lines and a common burner:

  (a) Two inlets — coal in the primary air and biomass in the swirling secondary air (vice versa).

  (b) Three inlets — two for primary air (central and annular), one for swirling secondary air.

Class I co-firing has the advantage of better control over fuel flow rates. Thermal output similar to coal-only firing requires higher biomass feed rates. Thus separate feeders facilitate controlling the biomass feed rate independent of the coal feed rate. Using a single feed line for a blend fuel has the risk of agglomeration occurring in the supply line, which may lead to a disconnection or blockage in the fuel supply. On the other hand, separate feed lines and separate burners increase capital and maintenance costs. Firing low heating value biomass independently of coal also has a risk of poor combustion efficiency.

Class II co-firing is relatively inexpensive in the sense that a single swirl burner can be used to fire the blend. The coal and biomass are fed separately, as in Class I co-firing. At the burner entrance, the two fuel streams are unmixed. In the quarl region of the burner, the two streams mix due to the swirling action of the secondary air. When good mixing is obtained, higher combustion efficiencies and lower emissions result. However, if a swirled is used, feeding one of the pulverized fuels in the swirling secondary air is likely to cause damage to swirled blades and this issue needs to be addressed. The swirling fuel stream can be avoided using Class II or introducing secondary air at an angle to achieve the swirl.

Damage to the swirl blades can also be avoided by pre-mixing the two fuels before they enter the burner.

Class III firing is the least expensive method since no separate feed lines and burners are required and the existing fuel lines can be used. The Class III co-firing method provides good mixing, high combustion efficiencies and low emissions. However, the risk of burner problems associated with feeding difficulties and maintaining similar thermal input are obvious concerns for the boiler operators. In order to have the same heat throughput rates when co-firing, the following relationship is obtained.

Coal: sawdust blend will have a heating value about 3% less compared to coal. The co-firing can be through suspension or stoker boilers. In addition, fluidized bed combustion of coal/biomass blends falls under this category of co-firing.

Biomass is an attractive renewable fuel to supplement coal combustion in utility boilers. Coal co-firing was successful with up to a 20% biomass mix. Results of extensive applications have shown that co-firing of biomass with coal have accomplished the following:

- Increased boiler efficiency,
- Reduced fuel costs,
- reduced emissions of NOx and
- Reduce fossil CO_2.

Every ton of biomass co-fired directly reduces fossil CO_2 emissions by over 1 ton. Woody biomass contains virtually no sulfur, so SO_2 emissions are reduced in direct proportion to the coal replacement. Biomass is a re-generable bio-fuel. When a fossil fuel is replaced by a bio-fuel, there is a net reduction in CO_2 emissions. Biomass can contain considerable alkali and alkaline earth elements and chlorine, which, when mixed with other gas components derived from coal such as sulfur compounds, promotes a different array of vapor and fine particulate deposition in coal fired boilers.

4.10 PROCESS AND TECHNOLOGY STATUS

Biomass co-firing consists of burning biomass along with fossil fuels in coal- and gas–fired power plants. This brief deals with biomass co-firing in coal power plants, which is by far more widespread and extensively proven than biomass co-firing in gas-fired plants

1. Co-firing can play an important role in increasing the share of biomass and renewable sources in the global energy mix and reducing greenhouse gas (GHG) emissions. Only a relatively low investment is needed to adapt or retrofit existing conventional coal power plants for biomass co-firing, or to build new power plants specifically designed for co-firing. Co-firing biomass in coal-fired power plants offers advantages with respect to using biomass in dedicated power plants. Advantages include higher efficiency (i.e. modern coal power plants are more efficient than smaller-scale dedicated biomass power plants), lower sulfur emissions (due to biomass combustion), lower costs (due to the larger size of coal power plants) and no need for continuous biomass supply because the plant can burn coal if biomass is not available. However, the use of two different fuels increases the complexity of power generation from both a technical and regulatory point of view. Co-firing activity is not easy to track since individual plants may change the quantity and type of biomass used and may use co-firing either on an experimental or commercial basis.

2. A previous count in 2009 by the IEA Bio-energy Implementing Agreement identified globally some 150 plants using coal or lignite along with biomass. The majority of these plants are located in northern Europe and in the United States, with some units in Asia

3. It must be noted that a considerable number of these plants use biomass as their primary fuel and coal as a standby or start-up fuel. Most of them are combined heat and power (CHP) plants, and many of them produce only electric power. Their capacity ranges from 50-700 MWe. Most plants are operated by utilities, but industry also plays an important role, especially in sectors, such as pulp and paper or wood processing. Biomass feedstock includes forestry and agriculture residues (e.g.

sugar cane bagasse), animal manure, wastes, such as sawdust or bark from the timber industry, waste wood and dedicated energy crops (e.g. short-rotation coppices). The sources vary greatly between countries, depending on their local natural endowments, their industrial potential and their biomass energy use.

Handling and combustion characteristics of vegetal biomass can be substantially improved through pelletisation and torrefaction. Pelletisation is a process to physically densify fine wood particles (e.g. sawdust) into compact, low-moisture and low-eroding capsules by applying pressure and heat. Advanced ("black") pellets can also repel water, thus improving logistics and storage options.

Torrefaction consists of biomass heating in the absence of oxygen, thus creating a charcoal-like substance with reduced moisture, small particle size, minimal biological degradation and increased energy density. After torrefaction, biomass can be milled and compressed to very dense pellets or briquettes. Torrefaction plants require significant capital costs (and large feedstock availability to compensate for the investment) but are expected to have lower operation costs than pelletisation plants. There are currently more than ten demonstration plants. Furthermore, research institutes around the world are working on the improvement and standardization of biomass pellets in terms of energy density, humidity, environmental properties, durability and the entire production process from the raw material to storable pellets.

As for the regional use of different biomass feedstock, bagasse is used as an alternative fuel along with coal in developing countries and regions with a large sugarcane production, such as Mauritius, La Réunion, Guatemala, Guadeloupe, India, Dominican Republic, while countries, such as Malaysia and Thailand, have explored the use of rice husks. Other countries, like Brazil, have significant bagasse co-generation capacity but do not combine biomass with fossil fuels.

4.11 CO-FIRING TECHNOLOGIES

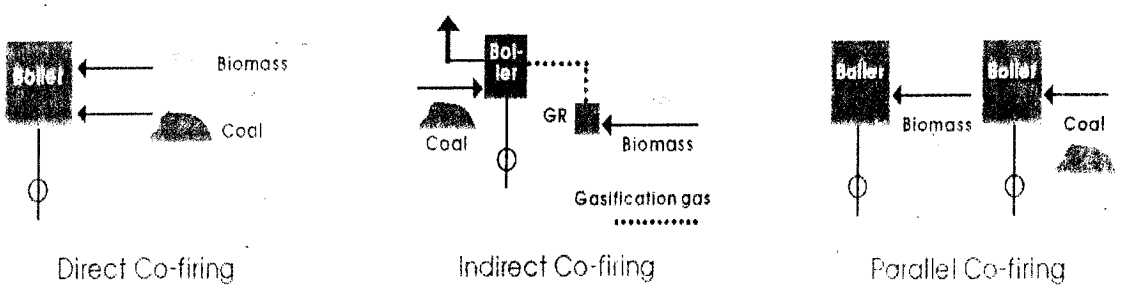
Co-firing includes three major technologies:

Direct co-firing is the simplest, cheapest and most common option. Biomass can either be milled jointly with the coal (i.e. typically less than 5% in terms of energy content) or pre-milled and then fed separately into the same boiler. Common or separate burners can be used, with the second option enabling more flexibility with regard to biomass type and quantity.

Indirect co-firing is a less common process in which a gasifier converts the solid biomass into a fuel gas that is then burned with coal in the same boiler. Though more expensive because of the additional technical equipment (i.e. the gasifier), this option allows for a greater variety and higher percentages of biomass to be used. Gas cleaning and filtering is needed to remove gas impurities before burning, and the ashes of the two fuels remain separate.

Parallel co-firing requires a separate biomass boiler that supplies steam to the same steam cycle. This method allows for high biomass percentages and is frequently used in pulp and paper industrial facilities to make use of by-products from paper production, such as bark and waste wood.

Figure 4.7: Different Biomass Co-Firing Configurations



Co-firing more than 20% of biomass in terms of energy content is technically feasible today. Depending on the plant set-up and the chosen co-firing technology, substitution of more than 50% of coal can also be achieved. However, in most cases co-firing levels are below 5%, exceeding 10% on a continuous basis only in about a dozen coal-fired plants worldwide. The co-firing mix also depends on the type of boiler available. In general, fluidized bed boilers can substitute higher levels of coal with biomass than pulverized coal-fired or grate-fired boilers.

However, pulverized fuel combustion is much more widespread and in some specific pulverized coal-fired installations, a 100% conversion from coal to biomass has been demonstrated. In the Netherlands and the United Kingdom, the full conversion of large coal-fired power plants to 100% biomass has been considered. However, logistical and economic constraints limit the conversion to a few plants with suitable infrastructure (cf. availability and cost of feedstock.

Biomass co-firing is more cost-effective in combined heat and power plants, which produce useful heat in addition to power. CHP is often used in industrial facilities where there is specific demand for both heat and power or in combination with district heating networks. Since CHP plants offer a higher overall efficiency than power plants, they also enhance the economics of biomass co-firing

4.12 TECHNOLOGY PERFORMANCE

Efficiency of Biomass Co-firing –Overall, the net electric efficiency of a coal/biomass co-firing plant typically ranges from 35-44%, depending on the plant technology, size and specific biomass feedstock. Direct co-firing results in slightly higher efficiencies (i.e. around 2% points) than indirect and parallel co-firing because of the conversion losses in the biomass gasifiers and boilers. The overall efficiency of direct co-firing falls with higher percentages of biomass due to fouling and slagging, associated corrosion, especially in pulverized coal-fired or grate-fired boilers. The overall efficiency of direct co-firing in coal-fired power plants with fluidized bed boilers is less sensitive to higher levels of biomass, although high levels require more sophisticated boiler and fuel handling control systems. Furthermore, fluidized beds

can handle biomass with larger particle sizes (<72mm instead of < 6mm) and higher moisture content (10-50% instead of < 25%) than pulverized boilers. However, in general co-firing in modern, large and highly-efficient coal power plants results in a biomass conversion efficiency that is significantly higher than what can be achieved in small (<10 MW) and medium-scale (10-50MW) dedicated biomass power plants with efficiencies of 14-18% and 18-33%, respectively . Apart from the higher efficiency, the economies of scale of large power plants will also lead to lowered costs for the energy provided per unit of biomass fuel used.

Co-firing Economics

While the environmental advantages of co-firing are promising, the economy of co-firing for any plant is site-specific and depends on several factors. Some of these factors are related to the plant design--e.g., costs can increase significantly if plant retrofit includes addition of facilities for feedstock size reduction, wood drying or separate feed systems for wood fuels. Generally, the capital costs for plant retrofitting to accommodate co-firing are relatively. The lowest-cost opportunities, by far, are with cyclone boilers, where capital costs are low. However, determining whether a co-firing plant can be run economically enough to cover these capital costs is largely a matter of the availability and price of biomass feedstock within 50 to 100 miles of the plant

Sustainability, Potential and Barriers

The substitution of 10% of the global coal-fired capacity by co-firing would result in about 150 GW biomass capacities. In comparison, today's co-firing capacity is estimated at between 1-10 GW (the variability being associated with the actual biomass share in co-firing plants), and the total installed biomass capacity amounted to some 62 GW in 2010. Therefore, a large co-firing potential exists, but a substantial increase would pose problems regarding the availability of biomass, which can also be used for bio-fuels and biomaterials production. While estimates of biomass resources vary greatly, realistic assessments should only account for Sustainable biomass - that is, resources that neither competes with food production nor involve land-use changes with negative impacts on the climate and environment. On this basis, the Intergovernmental Panel on Climate Change (IPCC)

estimates a global sustainable biomass energy potential of 100-300 EJ per year, mostly based on agriculture and forestry residues and ligno-cellulosic feedstock.

The energy use of biomass can add value to the forestry and agriculture sectors of developing and emerging countries. Recently, biomass production and trading from Latin America, Africa and Asia have increased significantly, although long-distance transportation reduces the benefit of using biomass. In addition, international cooperation is needed to ensure the sustainability of biomass production. The Global Bio-energy Partnership (GBEP) and other organizations are in the process of finalizing indicators, as well as certification processes, to ensure the sustainability of biomass production. Biomass co-firing based on residues and wastes has been recognized by the United Nations Framework Convention on Climate Change (UNFCCC) as a technology to mitigate GHG emissions so that countries can sell carbon credits associated with their co-firing projects.

GHG Emissions and Environmental Impact

Biomass co-firing offers a comparatively low-cost way to reduce greenhouse gas (GHG) emissions. As the combustion of biomass is considered carbon neutral (i.e. the CO_2released in the process is withdrawn from the atmosphere by photosynthesis during the plant's growth

Co-fired power plants release less net GHG emissions than conventional power plants. The cost of the precluded emissions is relatively low because the incremental investment costs for retrofitting or building new co-fired power plants is modest in comparison with other options to reduce power generation emissions. If combined with carbon capture and storage (CCS) technologies, biomass co-firing results in negative GHG emissions (i.e. net removal of CO_2 from the atmosphere), also referred to as "biogenic car-bon sequestration" Assuming an average level for CO_2 emissions from coal combustion of 95 kg/GJ, it is estimated that the CO_2 emissions in 2035 could be reduced by between 45-450 million tons per year if 1-10% of the coal fuel input were replaced by biomass. This estimate assumes that upstream emissions of biomass supply are negligible, although the supply chain also involves GHG emissions. While biomass co-firing can reduce the net GHG emissions of coal

plants, other polluting emissions deserve a specific assessment. Co-firing typically reduces sulfur dioxide, which leads to acid rain, and other harmful emissions as compared to coal, but the extent of such reductions depends strongly on the specific biomass feedstock, plant technology and operation. For example, using treated wood waste as fuel (e.g. from furniture or demolition) may require filtering of toxic gases, ash decontamination or a special design for the combustion systems to deal with chemicals contained in wood coatings, glues or preservatives. The reduction of biomass particulate emissions may require attention if co-firing occurs in smaller-scale power plants with low-efficiency particulate filters and no de-sulfurization, which usually traps fine particles in a parallel process.

In terms of water consumption, the impact of biomass co-firing depends on the biomass type and growth conditions. In many cases, co-firing can positively impact water use in coal-fired power plants; for example, if waste is used as the feedstock.

Other policies to support co-firing include CO_2 emissions trading schemes

Policies to support co-firing include co_2 emissions trading schemes (e.g. the EU Emissions Trading System or EU ETS), the removal of fossil-fuel subsidies, incentives for converting power plants into co-fired CHP plants, and mandatory co-firing quota schemes. Supporting policies are in place in EU countries (i.e. Austria, Denmark, Finland, the Netherlands, Sweden and the United Kingdom) and the United States. Emerging economies with large productions of agricultural waste and coal-based electricity (e.g. China and India) are also well-positioned to implement co-firing

Potential for Developing Countries

Co-firing offers advantages for emerging and developing countries since the use of waste from forestry and agriculture will increase the economic value of these sectors, which are usually strong components of the economy in these countries.

Instead of being burned on the fields, as is commonly done, agricultural waste could be used profitably in co-firing power-plants

However, international cooperation is needed to ensure the environmental and social sustainability of biomass exploitation (e.g. guarding against land-grabbing or deforestation, biodiversity loss in connection with large-scale monocultures). Of key importance is the fact that biomass co-firing has been recognized as a mitigation technology by the UNFCCC and that countries can sell carbon credits associated with their co-firing projects. Also important is biomass trading, which is increasing swiftly, driven by high fossil fuel prices and policies to reduce GHG emissions. While almost no woody biomass was traded in 2000, the global 2009 net trade in woody pellets amounted to about 75 PJ. Expectations are that up to 5% of total biomass use in 2020 could be sourced by international trade, with North America, Africa, Brazil and Russia as the major suppliers. International trading, however, implies transportation and energy consumption, thus reducing the benefit of the use of biomass.

Pakistan is passing through a challenging phase in terms of meeting its energy requirements Prices of conventional energy sources are soaring day after day, causing negative impact on the country's economy. The solution lies in exploring locally available energy resources, especially Alternative / Renewable Energy (ARE) technologies in the country.

Pakistan, an agriculture-based country, produces large amounts of agriculture residues/biomass such as cotton stalks, rice, husk and bagasse that can be utilized for generating electricity. The use of biomass for generation of power is globally considered as environment friendly and economically feasible.

Future of Cogeneration

In the future, the sources of biomass for co-firing may come from energy crops, such as willows and switch grass, grown directly for use in power production.

Also, a number of other issues remain to be resolved and are the subject of continuing research and discussion. Concern involves the possibility for increased slagging and fouling on boiler surfaces due to the firing of high-alkali herbaceous biomass fuels such as switch grass. Depending on the temperature and chemical conditions in the furnace, alkali vapors

may combine with sulfur and silica to form low-melting-point compounds, which lead to slagging.

In general, any organic fuel can be considered a biomass fuel. For the context of this discussion, biomass is used to describe waste products and dedicated energy crops. Waste products include wood waste material (e.g. saw dust, wood chips, etc), crop residues (e.g. corn husks, wheat chaff, etc.), and municipal, animal and industrial wastes (e.g. sewage sludge, manure, etc.). Dedicated energy crops, including short-rotation woody crops like hard wood trees and herbaceous crops like switch grass, are agricultural crops that are solely grown for use as biomass fuels. These crops have very fast growth rates and can therefore be used as a regular supply of fuel.

Biomass fuels are considered environmentally friendly for several reasons. First, there is no net increase inCO_2 as a result of burning a biomass fuel (i.e. fossil generated CO_2). Biomass consumes the same amount of CO_2 from the atmosphere during growth as is released during combustion. Therefore, blending coal with biomass fuels can reduce fossil-based CO_2 emissions. Co-firing of biomass residues, rather than crops grown for energy, brings additional greenhouse gas mitigation by avoiding CH4 release from the otherwise land filled biomass. It is believed that CH_4 is 21 times more potent than CO_2 in terms of global warming impact. Most biomass fuels have very little or no sulfur and therefore net SO_2 emissions can also be reduced by co-firing coal and biomass. This attribute is particularly desirable when co-firing with high sulfur coals. The alkaline ash from biomass also captures some of the SO_2 produced during combustion. Typically, woody biomass contains very little nitrogen on mass basis as compared to coal. In addition, most of the fuel nitrogen in biomass is converted to NH radicals (mainly ammonia, NH_3) during combustion. The ammonia reduces NO to molecular nitrogen (essentially providing an insituthermal De NOx source). Hence, biomass co-firing can also result in lower NOx levels.

4.13 BIOMASS POWER GENERATION TECHNOLOGIES

There can be many advantages to using biomass instead of fossil fuels for power generation, including lower greenhouse gas (GHG) emissions, energy cost savings, improved security of supply, waste management/reduction opportunities and local economic development opportunities. However, whether these benefits are realized, and to what extent, depends critically on the source and nature of the biomass feedstock.

In order to analyze the use of biomass for power generation, it is important to consider three critical components of the process:

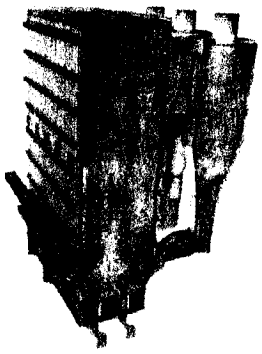
- Biomass feed stocks: These come in a variety of forms and have different properties that impact their use for power generation.
- Biomass conversion: This is the process by which biomass feed stocks are transformed into the energy form that will be used to generate heat and/or electricity.
- Power generation technologies: There is a wide range of commercially proven power generation technologies available that can use biomass as a fuel input.

The source and sustainability of the biomass feedstock is critical to a biomass power generation project's economics and success. There are a wide range of biomass feed stocks and these can be split into whether they are urban or rural.

A critical issue for the biomass feedstock is its energy, ash and moisture content, and homogeneity. These will have an impact on the cost of biomass feedstock per unit of energy, transportation, pre-treatment and storage costs, as well as the appropriateness of different conversion technologies.

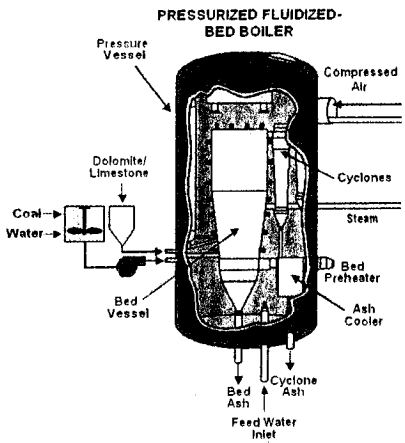
4.14 COMBUSTION TECHNOLOGIES

Atmospheric Fluidized bed combustors (AFBC)



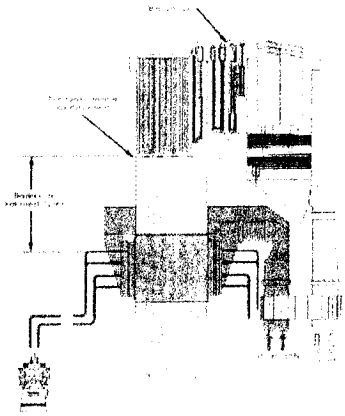
The technology is based around a fluidized movement of fuel and air. It is an established commercial technology for coal co-combustion plants. The combustion chamber has a bed, usually made of sand that creates a medium to maintain high combustion temperatures despite possible impurities, low energy content or high moisture contents of the injected fuel. The technology is therefore suitable for a variety of fuel qualities and moistures, for example wood and other biomass types. Within the chamber, 90% of the bed is sand and ash, the rest is fuel. Emissions are considerably lower than grate combustors, for example SO_2 and NOx. Little investment is required to change to biomass operation. The AFBC has several varieties: Circulated, Bubbling and stationary fluidized bed boilers are the most common types of this technology.

Pressurized Fluidized Bed Combustor (PFBC)



The principles are exactly the same as the AFBC except that the combustion takes place at higher than atmospheric pressure. Therefore, there is the problem of crossing the biomass fuel across the pressure boundary into the reactor.

Pulverised Combuster

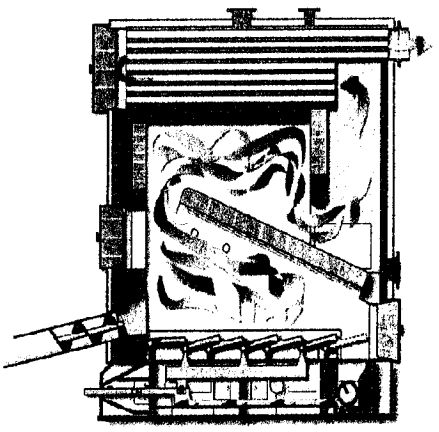


This technology depends on pre-processing the fuel, whether coal or biomass, into fine material (generally <1mm) ready for injection into the burner. The choice of fuel is more restricted, however it is still the most widely used technology in the world for power generation for utilities. The reduced emissions are one reason for choosing this technology but the low energy density means a higher volume flow to the boiler

and a high volume of locally available biomass. The Longannet Coal fired power station in Scotland, UK, is now co-firing with biomass (sewage sludge) - see opposite. There are a number of ways to employ biomass for power generation with this technology:

1. Dedicated biomass burners, separate from the coal fired burner;
2. Mixing of prepared biomass fuel upstream with coal before firing;
3. Pre-mixing biomass in the coal preparation plant

Grate Combustor



Fuel is directly combusted over a grate with no further processes or circulation of air. It is the simplest and oldest design for combustion of solid fuels. However, it is the least efficient and has high flue gas emissions. Chamber combustion temperatures are higher than the other technologies and range from 800 to 1400 C. Wood fuels can be used in the grate combustor quite un-problematically but for other biomass types, it is generally sensitive to changes in fuel quality and moisture. Some experiences have shown that recycled fuels in small plants is relatively safe in terms of emission levels but in other cases there have been ignition and poor combustion problems related to biomass fuelling.

4.15 TYPICAL COFIRING APPLICATIONS

Industrial co-firing

wood and agro-industries, food processing, pharmaceutical, pulp and paper, oil refinery, textile industry, steel industry, cement industry, glass industry, ceramic industry

Residential/commercial/institutional cogeneration

Hospitals, schools & universities, hotels, houses & apartments, stores & supermarkets, office buildings

Review of Alternatives

5.1 ALTERNATIVES

It is the requirement of the best practice that the EIA/IEE 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.

No Action (Zero Option)

This option requires the EIA/IEE to consider the potential positive and negative impacts that may arise if the project did not go ahead. The "zero option" would result primarily in negative impacts.

The project will be using available quantity of biomass (renewable energy source) along with coal for generation 7.5 MW electricity for their textile unit 365 day in a year. And additional would be to supply much needed power to national grid. The use of biomass 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 textile industry which will help to secure its future and so offset some of the current and increasing pressures on the financial viability of the textile sector. Additionally the existing ecological habitats will not be disturbed as transmission line to Grid Station is in close vicinity of the project area.

5.2 PROPOSED POWER PLANT SITE

When the need for additional power generation capacity was confirmed, Hytex 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 IEE is intrinsically linked with the Textile unit as discussed within the project description. This linkage is the provision of power supply to the factory from the cogeneration plant. Due to the physical restrictions within the textile unit 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 Textile unit, would add significant additional capital and operational costs 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 is adjacent to the Textile unit and is a part of developed Hyderabad Industrial Trading Estate; has all the infrastructure facilities such as water, road links, and railway station.

-------- proposed grid station is located at about 26 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 S.I.T.E Area. Similarly, experienced and skilled managerial manpower is also available in the area.

5.3 COGENERATION OPTION

Cogeneration, also known as Combined Heat and Power (CHP), is the on-site production of multiple types of energy — usually electricity, heat and/or cooling — from a single source of fuel. Cogeneration often replaces the traditional methods of acquiring energy, such as purchasing electricity from the power grid and separately burning natural gas or oil in a furnace to produce heat or steam. While the traditional method of purchasing electric energy from a utility is convenient, it is very inefficient and wastes almost 75 percent of the energy in the original fuel due to production and transportation losses

On-site cogeneration systems convert 70 percent to 90 percent of the energy in the fuel that is burned into useful electricity or heat. Depending on the application, the integration of power and heating/cooling production into one on-site cogeneration system can often produce savings of up to 35 percent on total energy expenditures.

Cogeneration has been adopted as standard means of energy generation. With the use of efficient processing and energy management systems, energy from biomass, over and above the Textile unit needs, is available and can be exported conveniently in the form of electric power. Application of 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.

5.4 BIOMASS ENERGY

Biomass energy is the energy which is contained inside plants and animals. This can include organic matter of all kinds: plants, animals, or waste products from organic sources. These sorts of energy sources are known as bio-fuels and typically include wood chips, rotted trees, manure, sewage, mulch, and tree components. Chlorophyll present in plants absorbs carbon dioxide from the atmosphere and water from the ground through the process of photosynthesis. The same energy is passed to animals when they eat them. It is considered to be as renewable source of energy because carbon dioxide and water contained inside plants and animals are released back in to the atmosphere when they are burned and we can grow more plants and crops to create biomass energy.

In many ways, biomass is a new source of power. While wood has always served as a fuel source for fires and ovens and conventional heating methods, biomass energy advancements are a few steps beyond that. Now these biomass fuel products are harvested and mass-produced and used in everything from engines to power plants.

No Harmful Emissions: Biomass energy, for the most part, creates no harmful carbon dioxide emissions. Many energy sources used today struggle to control their carbon dioxide emissions, as these can cause harm to the ozone layer and increase the effects of greenhouse gases, potentially warming the planet. It is completely natural, has no such carbon dioxide side effects in its use.

Clean Energy: Because of its relatively clean use, biomass energy, when used in commercial businesses such as airlines, receives tax credit from the US government. This is good for the environment and good for business. It does release carbon dioxide but captures carbon dioxide for its own growth. Carbon dioxide released by fossil fuel are released into the atmosphere and are harmful to the environment.

Abundant and Renewable: Biomass products are abundant and renewable. Since they come from living sources, and life is cyclical, these products potentially never run out, so long as there is something living on earth and there is someone there to turn that living things components and waste products into energy. In the United Kingdom, biomass fuels are made from recycled chicken droppings. In the United States and Russia, there are plentiful forests for lumber to be used in the production of biomass energy.

Reduce Dependency on Fossil: It has developed as an alternate source of fuel and have helped them to reduce their dependency on fossil fuels.

Reduce Landfills: Another benefit of this energy is that it can take waste that is harmful to the environment and turn it into something useful. For instance, garbage as landfill can, at least partially, be burned to create useable biomass energy. -

Less contribution to acid rain phenomenon: less emissions of sulfur dioxide (so_2) and nitrogen oxides (NO_x) resulting from biomass fuel combustion results in less contribution to acid rain phenomenon

Elimination of unwanted solid wastes: Solid waste is a part of Biomass fuel when it is used is consumed as bio-fuel results in its elimination.

5.5 STATE OF TECHNOLOGY

Biomass refers to any biologically sourced feedstock that ultimately derives from a plant source. Through photosynthesis, green plants convert solar energy to chemical energy stored in the bonds of biological molecules. This energy is released through various chemical pathways and can be used for everyday plant functions. Because plants originally sequester the carbon in biomass from the atmosphere, biomass is considered a carbon neutral energy source.

Chemical energy in the biological molecules of plants can be released through combustion or other thermo chemical processes for use in power generation. Biological processing to convert biomass to liquid fuels is another, more common, route for converting biomass to energy. Nonetheless, this thesis will focus on the biomass to power route through combustion in a boiler. Biomass combustion for power generation is a mature technology that has the potential to decrease GHG emissions from electricity generation in the near term. In addition, if a carbon capture and sequestration unit is added to a biomass power plant, then part of the carbon dioxide captured from the air by the biomass will be sequestered and possibly lead to negative carbon emissions.

Although biomass has the potential to contribute significantly to low carbon power generation, implementation of the technology has not been widespread. Worldwide dedicated firing and co-firing of biomass has been practiced at over 200 power plants with capacities as high as 4000 MW (operated by Drax Power in North Yorkshire, UK). In the United States the EIA reported that the nameplate capacity of plants firing wood or wood derived fuel was 3498 MW.

Plants using other biomass fuels (including municipal solid waste, landfill gas, sludge waste, and agricultural byproducts, among others) in the US have a nameplate capacity of 5043 MW. (EIA, 2011b) In terms of net power generation in the US, biomass made up 1.4% of power generation in 2010.

In biomass power plants, wood waste or other waste is burned to produce steam that runs a turbine to make electricity, or that provides heat to industries and homes. Fortunately, new

technologies — including pollution controls and combustion engineering — have advanced to the point that any emissions from burning biomass in industrial facilities are generally less than emissions produced when using fossil fuels (coal, natural gas, oil). Re-Energy has included these technologies in our facilities

The biomass material that we use for fuel is loaded into boilers at ReEnergy's green energy facilities and heated in a highly controlled and regulated process that creates steam. The steam, under pressure, is fed into a turbine that spins and drives a generator to create electricity. Energy from biomass is reliable as it is free of fluctuation unlike wind power and does not need storage to be used in times of non-availability as is the case with solar

5.6 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 sulfur and ash content, which will lead to severe environmental hazards. The project's proposal for using high quality imported coal is economically not feasible. The best option for environmental and economic reasons In the absence of any cheaper fuel, cogeneration using mix fuel (Biomass+ coal) is of prime importance.

5.7 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 biomass and coal locally the option of using other renewable energy sources will be highly cost ineffective.

Moreover, high wind speed is only apparent for short periods of time in the project site area and hydro potential does not exist. Therefore, none of the currently available other renewable energy sources, at the utility level, will be able to meet the current needs.

Anticipated Environmental Impacts & Mitigation Measures

6.1 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 IEE study is given below:-

Scale: Extent of Impact

▲▲▲ = High

▲▲ = Medium

▲ = Low

O = No impact

▼▼ = locally favorable

▼ = regionally favorable.

For evaluation rating, the National Environmental Quality Standards (NEQS) and International guidelines are used as reference guide. Various parameters of extent of environmental impacts are described below

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

6.2 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 on Erosion/Sedimentation = ▲ (Low)

Erosion/Sedimentation

- The proposed project does not require 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. No trees removal will be required in any area where construction conflicts exist.

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. Site preparation and construction activities will not require any explosives. The plant site is in level condition, 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 vegetated with native plant materials.

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, areas will be planted predominantly with native vegetation to control erosion.

Extent of Impact on Erosion/Sedimentation = ▲ (Low)

Air Quality

Major sources of dust emissions during construction include:

- Excavation.
- Earthwork.
- 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 are likely to 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 road 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. Emissions 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 some 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 6 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.]

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.

Extent of Impact on Surface 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 relatively large 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 6 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 National and International 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

6.3 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 site is situated in the industrial area.. 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 residents leaving the nearby areas as the project area is located on the main road of the industrial area quite away from the residential area. 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.

6.4 SOCIO-ECONOMIC IMPACTS

Most of construction workers are anticipated to be hired from the nearby where the project site is located. In addition, general contractors/vendors, consultants and engineers from within the province/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 T. M. Khan road.. However, during construction of the power plant, no conflicts are anticipated with cultural resources in the area.

Table 6.1: Checklist of Action Affecting Environment and Significance of their Impact

Actions Affecting Environment Resources & Values	Damage to Environment	Recommended Mitigation Measures	Significance of Impact
A. Environmental Problems due to Project Location			
1. Changes in hydrology affecting existing property values of land	1. Damages to land due to erosion and/or accretion	1. Careful design and planning to minimize / offset problem	O
2. Changes in drainage pattern	2. Damages due to changes in flooding / accretion, erosion hazards	2. Careful design to minimize / offset problem	▲
2a. Stream Flow Obstruction	2a. Conflicts with other beneficial water uses	2a. Appropriate sharing of water rights	O
3. Changes in land	3. Possible loss	3. Careful planning	O