

# *2x350 MW SUPERCRITICAL COAL-FIRED POWER PLANT*



## *ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT: SCOPING REPORT*



DECEMBER 2015

**2x350 MW SUPERCRITICAL COAL-FIRED POWER PLANT**

**ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT:**

**SCOPING REPORT**

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## PROFILE OF ESIA TEAM

The team of specialists conducting the environmental and social impact assessment for the 2x350MW Supercritical Coal-Fired Power Plant is composed of a consortium comprising Premier Resource Consulting, ESL Consulting and Envaserve Research Consult. The team membership have over fifteen years experience and sector specialist knowledge.

The member specialists and expected roles on the team are presented below:

TEAM	NAMES	TASK
ESIA Specialist and Safety and Risk Design	Mr. Felix Quansar (ESIA LEAD CONSULTANT)	Coordination of the entire study Baseline assessment Technology and Process Analysis Environmental Impact Analysis Safety and Risk Design Public Consultation Drafting Reports and Quality Assurance
Subtidal and Intertidal Ecology	Lead: Mr. Ayaa Kojo Armah (ESIA ASSISTANT LEAD CONSULTANT) Assistant: Amanor Kisseih	Assist Coordination of Entire Study and Quality Control Coordinator for Ecological Survey & Habitat Assessment Study Loss and disturbance to subtidal benthos
Modeling Specialist	Lead Mr. Emmanuel Lamptey Assistant Selorm Dzako Ababio	Air quality monitoring Emission Monitoring Noise Monitoring Conducting Air Emission Dispersion, Noise and Seawater modeling Green House Gas Emission and Climate Change assessment
Assistant Ecology Review Coordinator	Anthony Bentil	Will assist Project manager in all activities which include project planning, baseline surveys, environmental and social impacts identification, analysis and mitigation. Will be involved in stakeholder consultations and report writing.
Marine Mammals and Turtles	Lead: Mr. Andy Agyekumhene  Assistant: Enoch Armah	Potential impacts on marine mammals, including endangered and vulnerable species that are thought to be present in the local area and known to be present in the wider area; Potential impacts on sea turtle species that may nest in the area of works and migrate across the area; rapid sea turtle field verification survey
Vegetation/Forest Ecologist	Lead: Dr. James K .Adomako  Assistant: John Amponsah	List the prominent plant species (trees, shrubs, grasses and other herbaceous species of special interest) present for vegetation unit and ecosystem delimitation. Identify plant species of conservation importance; which could possibly occur at the site Make recommendation on suitability of site for the project regarding the extent of impacts on the ecology

Marine, Fresh Surface and Ground Water Quality Related Impacts/ Marine Sediments	Lead: Dr. Ansa-Asare  Assistant: Victor Mante	pH and Temperature Salinity and Conductivity Biological and Chemical Oxygen Demand Turbidity Dissolved and Suspended Solids Hydrocarbons Oil and Grease Heavy Metals Nutrients Microbiology Grain size analysis
Fisheries	Lead: Richmond Quartey Assistant: Emmanuel Klubi	Potential impacts on fish nursery and spawning grounds Plankton and benthos assessment
Animal Ecologist (Terrestrial)	Lead: Charles Christian Amankwah Assistant: Francis Seku	Identify animal/faunal species of conservation importance; which could possibly occur at the site Make recommendation on suitability of site for the project regarding the extent of impacts on the ecology
Sociologist/Stakeholder Consultation	Lead: Adu-Nyarko Andorful Assistant: Bright Yeboah	Possess extensive experience in the six coastal districts with local communities and other stakeholders. Will lead all stakeholder consultations Socio-economist/rap expert
Terrestrial Soil and Geology Investigation	Lead: Dr. D. F. K Allotey Assistant: Moses Ocquaye	Site soil contamination and qualification assessment including physicochemical analysis, pH, Sulphate, Chloride, Poly Aromatic Hydrocarbon (PAH) and Total Petroleum and Hydrocarbon (TPH)
Valuation	Lead: Yaw Osei-Wusu Peprah Assistant George Nimako	Land acquisition processes Valuation Drafting Property impact Report
Landscape Seascape	Lead: Maxwell Mensah Clotley	Landscape, Seascape and Visual Impact Assessment Historical resource and cultural heritage assessment

## LIST OF ABBREVIATIONS

VRA	Volta River Authority
SEC	Shenzhen Energy Group Co., Ltd.
CHT	Coal Handling Terminal
MOF	Material Offloading Facility
FGD	Flue Gas Desulfurization
ESP	Electro-static Precipitator
RO	Reverse Osmosis
UF	Ultra Filtration
EDI	Electro Deionization
DWT	Dead Weight Tons
M	Meter
MM	Millimeter
HP	Horse Power
NO <sub>x</sub>	Nitrogen Oxides
SO <sub>x</sub>	Sulphur Oxides
CO <sub>x</sub>	Carbon Oxides
PM	Particulate Matter
NEQG	National Environmental Quality Guideline
Tpd	Tons per Day
LULUCF	Land Use, Land-Use Change and Forestry sector.

## EXECUTIVE SUMMARY

Shenzhen Energy Group Co., Ltd. (SEC) in collaboration with Volta River Authority (VRA) intends developing a 2×350MW supercritical coal-fired power generating facility (including the affiliated coal handling terminal) to be situated along the coastline of Ghana.

The project is intended to contribute considerably to addressing the domestic power generation shortfall in the near future to improve Ghana’s future power balance. Consequently, the project strategically provides reliable basis for Ghana’s base load operation while optimizing power generation portfolio and generation reliability in Ghana at favourable price advantage to support the country’s economic and social development.

In accordance with the Environmental Protection Agency Act 1994, Act 490 (Parts 1&II) and Environmental Assessment Regulations 1999, LI 1652, an Environmental and Social Impact Assessment is required prior to the development of the proposed project. As a part of the process a scoping report is demanded to set out and validate the extent of the Environmental Impact study and ascertain the significance of the potential key impact areas of the development.

This Scoping Report outlines the conditions of the environment earmarked to accommodate the proposed 2X350MW Supercritical Coal-Fired Power Plant project. The report describes the preliminary identification of all potential significant adverse environmental and social impacts on the terrestrial and marine ecology resulting from the pre-construction, construction, operation and decommissioning activities of the proposed project. The report further identifies the environmental resources and social aspects, which stand the risk of adverse impact from the development and implementation of the proposed project. Based on the preliminary consultations, review of secondary and primary data collected and the identified key issues of potential impact the Terms of Reference for the Environmental and Social Impact Assessment of the project have been developed and included.

The environmental and social impact assessment would comply with National Environmental laws and Quality Guideline, other relevant Ghanaian legislations which are applicable to the project and relevant international agreements and conventions. The ESIA will conform to a number of international guidelines and standards including the IFC Performance Standards particularly the Environmental, Health and Safety Guidelines for Thermal Power Plant.

The project is conceived to have a future expansion to an integrated 2000MW Supercritical Coal-Fired Power Plant with affiliated coal handling terminal, infrastructure, residential and outdoor area. The development of the project is structured as phase 1 involving the development of 2X350MW Supercritical Coal-Fired Power Plant and phase 2 involving the development of 4X350MW or 2X600MW Supercritical Coal-Fired Power Plant.

The generating units would comprise two power blocks each consisting of:

- A boiler based on supercritical pulverized coal technology
- A steam turbine and generator unit with 350 MW rated output
- A once through circulation cooling water system
- Electro-static Precipitator for removal of dust in flue gas
- Seawater Flue Gas Desulfurization for removal of SO<sub>x</sub> in the flue gas
- Low NO<sub>x</sub> combustion

The coal-fired power generating process would involve burning pulverized coal in a boiler (steam generator) to heat water to produce steam, which flows into the turbine, which spins the generator to produce electricity. The power produced would be evacuated through a 2x15 km 330kV transmission to the national transmission from Aboadze to Tema. The ash generated from combustion in the form of fly ash and slag would be transported to the ash storage yard using trucks. The ash yard is initially considered for 5 years ash accumulation.

The ancillary facilities to the power station include:

- ✓ 330kV transmission lines
- ✓ Once through circulation cooling water system
- ✓ Wastewater treatment system
- ✓ Firefighting system
- ✓ Coal unloading, storage, conveying and pulverization system
- ✓ Ash storage yard
- ✓ Residential quarters
- ✓ Access road

The Coal Handling Terminal (CHT) is proposed for 70,000DWT coal carriers mainly from South Africa where the coal will be sourced from. The CHT will also have a Material Offloading Berth designed for 10,000DWT vessels with length of 174m. The coal unloading facilities are two grap type ship unloader each of capacity 1500 tons/hour, which transfer the coal onto belt conveyors for transportation to the transfer tower on land.

The project, which is planned to commence in August 2016 and commission commercial operation in 2019/2020, is estimated to cost 1.5 billion US Dollars.

A pre-feasibility study has been completed to determine the selection of suitable power plant technology alternatives, power unit and plant size. The study furthermore reviewed fuel alternatives and plant location alternatives. Five possible sites were reviewed and two potential sites Akwidaa (Site 1) and Ekumfi (site 4) were eventually evaluated. Ekumfi Aboano became the preferred location to accommodate the coal-fired power generating plant, especially for reasons of minimal environmental impact and implications.

The consultation engaged various interest groupings with relation to the project development, with the overall purpose of soliciting viewpoints in respect of potential impacts of the project on society. The structure of consultation represents three levels identified as National, District and Local level consultations. A total of 20 meetings were held with 15 stakeholder groups. Stakeholders consulted included national, regional and district representatives.

The key responses from the consultations reflect usual concerns of a novel industry whose potential adverse impacts are quite new in Ghana. Even though most stakeholders welcomed the development of the coal-fired power project and the associated advantages, they showed concerns in respect of management of possible negative impacts. It became clear that there is limited knowledge and awareness of the operational features of coal-fired power plant and the advancement in technological efficiency and pollution controls. The proposed operation is new in Ghana and West Africa and significant sensitization would be crucial to garnering various stakeholder supports. In general more of the stakeholders emphasized the deployment of cleaner technology and best available technology to reduce the potential negative impacts especially relating to air emissions.

Two principal receptors are considered to have the potential of being influenced by the proposed operation and are identified as the marine and terrestrial environments. Review and identification of potential impacts and their significance have been based on analytical review of operational processes and resources demands and requirements. Particular attention is also given to alternative considerations and best available technologies.

The review has indicated the operation may potentially impact positively and adversely on the two identified key environmental receptors. Consideration of impact included potential ecological changes, environmental health impacts, occupational health and safety impacts, noise and air quality impacts as well as socio-economic impacts, greenhouse gas emission and global climate change.

The key potential environmental impacts and implications identification considered the activities during preconstruction, construction, operation and decommissioning activities.

The project is expected to comply with the relevant National, Regional and International legislations. Emissions and discharges are expected to meet the Ghana National Environmental Quality Guidelines Standards and related requirements. Moreover, the flue gas emission of the power plant will also meet the Thermal Power Guideline for Pollution Prevention and Abatement of the World Bank Group and Environmental Health and Safety Guideline for Thermal Power Plants (2008) of International Finance Corporation of the World Bank Group.

The preconstruction activities involved site investigations including drilling and sampling

of ground materials for geological and seismic purposes. Generally, the identified potential impacts, after mitigation measures applied where appropriate, were considered relatively insignificant on both terrestrial and marine ecology.

The construction activities are expected to involve site preparations including, blasting, clearing, cutting and filling earth works as well as construction of structures and civil works to house the power plant and machinery. In addition, the activities would cover construction of ancillary infrastructure including roads and drainage systems, residential facilities and coal handing terminal. The phase would also involve installation of power plant, machinery and equipment, transportation of materials and machinery and equipment as well as operation of construction machinery

The potential impacts on the terrestrial ecology would include possible changes in air quality, noise level, wastewater generation and discharges, solid waste generation, impact on ecosystem (flora and fauna), traffic and occupational health and safety.

The potential impacts of the construction activities on the marine ecology would include possible seawater pollution, air quality changes, noise level and solid waste generation.

The operational phase activities would include the operation of the coal handling terminal and affiliated Material Offloading Facility; the operation of the 2X350MW supercritical coal-fired power plant and the ancillary facilities and the running of the residential facilities.

The possible impacts on terrestrial ecology are identified to affect air quality, ambient noise, solid waste, generation of hazardous, vibration, waste disposal and health and safety issues, as well as social and economic impact.

The potential impacts on the marine ecology include seawater temperature changes, seawater pollution and noise pollution.

Impact identification at the decommissioning operation would be discussed in the ESIA.

Appropriate mitigation initiatives have been discussed and they are aimed at minimizing the possible impact implications on both the terrestrial and marine ecology.

The ESIA will describe the plans to be put in place to mitigate and manage impacts. The ESIA process will include engagement with the government and community and civil society stakeholders to obtain their views. The ESIA report, along with stakeholder comments will be submitted to the Ghana EPA for permitting assessment.

A consortium of Ghanaian environmental consultants namely Premier Resources Consulting, ESL Consulting and Envaserve Research Consulting is contracted to conduct the

ESIA. The ESIA will be conducted in accordance with the requirements of the Ghana Environmental Assessment Regulations of 1999 (LI 1652). The ESIA will also be conducted in consideration of the environmental and social performance standards of the International Finance Corporation (IFC) as well as the World Bank.

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## INTRODUCTION

### 1.1. Background

Shenzhen Energy Group Co., Ltd. (SEC) in collaboration with Volta River Authority (VRA) intends developing a 2x350MW supercritical coal-fired power generating plant (including the affiliated coal handling terminal) sited along the coastline of Ghana facing the Atlantic sea.

#### 1.1.1 *Shenzhen Energy Group Co., Ltd*

The Shenzhen Energy Group Co., Ltd. was incorporated in 1991 in China and became listed on the Shenzhen Stock Exchange in 1993. The key shareholders are State-owned Assets Administration Committee holding 48%, Huaneng International Power Inc. having 25% and the Public holding 27% share.

During the years SEC has developed its core business in power generation with environmentally friendly energy, gas business and related energy finance as subsidiary business both on the Domestic and International markets.

Currently SEC owns more than twenty subsidiaries or holding companies, including two public-listed companies, three coal-fired power plants, five gas power plants, six waste-to-power plants, a number of solar power stations and an ocean fleet with six Panama bulk carriers. At the end of 2014, the total installed capacity controlled by SEC was 8165 MW.

#### 1.1.2 *Volta River Authority*

Volta River Authority (VRA) is solely owned by the Government of Ghana and was established in 1961 by the Volta River Development Act, Act 46 of the Republic of Ghana to generate and supply electricity for the country. Presently, VRA is a major power generation company in Ghana combining hydro, thermal and solar plants to generate electricity for supply to the local and export markets.

The local market for power comprise of Electricity Company of Ghana, the mines, and industrial establishments, whiles the export market comprise of Communauté Electrique du Benin (CEB) (for the Republics of Togo and Benin) and SONABEL (Burkina Faso).

In the past, electricity generation and supply in Ghana has been dominated by hydro power, which accounted for all generation until the late 1990s. However, presently the situation has changed since the end of 2010 and Ghana's total installed thermal generating capacity has almost equaled the existing hydro generation capacity.

VRA operates hydroelectric power generation plants situated at Akosombo and Kpong;

also thermal plants situated mainly in Tema (Tema Thermal 1 & 2) and Takoradi (Takoradi Thermal Power Station T1, TICO/T2 and T3). In 2014, the total installed generation capacity was 2,022 MW. Currently, the thermal power generation plants using crude oil and gas as the fuel source play significant role in the power generation mix of VRA. VRA also operates a solar plant with installed capacity of 2.5 MW situated in the Northern Region of Ghana.

VRA has subsidiaries including Northern Electricity Distribution Company (NEDCo), Akosombo Hotels Limited, Volta Lake Transport Company and Kpong Farms Limited. Furthermore, VRA runs Health Services, Schools and Real Estate Departments, which are developed as Strategic Business Units.

VRA also supports the socio-economic development of the Volta Basin; operating as a local authority for the Akosombo Township and exercising administrative responsibility over the Akuse and Aboadze Estates. The Authority implements Environmental Management Programmes to mitigate the adverse impacts of its operations.

## 1.2. Purpose of the Project

The purpose of the project is to develop power generating plant contributing to addressing the domestic power shortage and particularly the future power balance in Ghana. Specifically the project is developed to serve:

- a) Meeting the electricity demand growth in Ghana with the peak demand forecast for 2020, 2025 and 2030 projected as 3652MW, 4960MW and 7000MW respectively. Accordingly, the power balance results show serious power supply shortage with generation deficit for 2020, 2025 and 2030 as 879MW, 1015MW and 3423MW respectively. Consequently, Coal-Fired Power Plant (phase I 2x350MW) coming on stream in 2020 will provide broader electricity market space for the power plant;
- b) Optimizing the power generation portfolio and improving power supply reliability in Ghana. Ghana experiences primary energy limitations due to water availability and oil and gas supply constraints. The stable sources of coal available in South Africa and on the international coal market will reduce Ghana's vulnerability to short- and long-term disruptions and ensure continuous supply to consumers. The Coal-Fired Power Plant could optimize the Generation Mix, and improve power supply reliability.
- c) Providing the base load operation and featuring high capacity factor. The capacity shortfall results indicate that Ghana will be under serious power supply shortage for a long time. So the coal-fired generation units can run with base load, and also

has relatively high equipment annual utilization hours. Therefore, the coal-fired power plant project can provide good economic return and strong profitability.

- d) Offering favorable fuel price of coal and giving the power generation units electricity price advantage. Coal is affordable source of energy, with coal cost, being historically more stable and favorable than oil and gas prices. The generation cost of coal-fired units is relatively low, accordingly the coal-fired units would have on-grid price advantage.

### 1.3. Project Objectives

The 2×350MW supercritical coal-fired power project seeks to provide electricity serving mainly the southern coastal area of Ghana and therefore providing a regional power plant.

### 1.4. The Environmental and Social Impact Assessment (ESIA) Process

In accordance with the Environmental Protection Agency Act 1994, Act 490 (parts 1&II) and Environmental Assessment Regulations 1999, LI 1652, the National Environmental Policy institutes and implements an environmental quality control programme requiring prior Environmental Impact Assessment of all new investments that would be deemed to affect the quality of the environment.

Environmental Impact Assessment aims to achieve:

- a) Compiling all relevant information relating to the proposed 2X350MW supercritical coal-fired power plant and affiliated facilities to inform the permitting process of the project to minimize environmental impacts.
- b) Identifying all important receptors and disclosing identified potential environmental impacts of project prior to project being started.
- c) Determining the significance of impacts and identifying mitigation measures to alleviate any significant adverse impacts.
- d) Ensuring modern, precautionary control alternatives are well considered and incorporated into design.
- e) Developing sustainable environmental practices.

The Environmental Assessment Procedure involves:

- a) Registration
- b) Screening
- c) Scoping
- d) EIA Study
- e) EIS Review
- f) Decision Making

### 1.5. Scoping Study

The scoping report sets out the scope or extent of the environmental impact assessment to be carried out by the applicant, and shall include a draft terms of reference, which shall indicate the essential issues to be addressed in the environmental impact statement

The purpose of the Scoping Report is to validate the extent of the Environmental Impact study and ascertain the significance of the potential key impact areas of the development, operation and decommissioning of the 2X350 MW coal-fired power plant, the coal handling terminal and related ancillary facilities.

The scoping exercise is stipulated to:

- a) Identify and specify the key environmental issues relevant to the establishment of the coal-fired power plant and the associated facilities for quick decision making and project site selection.
- b) Provide all relevant stakeholders the opportunity to contribute to the determination of important concerns to facilitate the preparation of comprehensive environmental and social impact statement on the development and operation of the coal-fired power plant.
- c) Identify gaps within the existing information for in-depth analysis of the potential impacts and determine the additional information requirements.
- d) Provide the basis for agreement with EPA on critical environmental impact issues of concern that should be addressed by the ESIA ensure providing adequate information on the Environmental aspects of the project to assist EPA evaluate the identified impacts, mitigation measures proposed and serve as basis for granting the Environmental permit in line with the Act 490 and L.I 1652.
- e) Enable comprehensive development of the Terms of Reference (TOR) for the ESIA study and also importantly obtaining the approval of EPA on the TOR.

Where the applicant is asked to submit an environmental impact statement, the applicant is required to take the responsibility to:

- a) Give notice of the proposed undertaking to the relevant Ministries, government departments and organizations and the relevant Metropolitan, Municipal or District Assembly;
- b) Advertise in at least one national newspaper and a newspaper circulating in the locality where the proposed undertaking is to be situated;
- c) Make available copies of the scoping report for inspection by the general public in the locality of the proposed undertaking.

## LEGAL, REGULATORY AND ADMINISTRATIVE REQUIREMENTS

This chapter outlines the legislative and administrative framework including international treaties, conventions and industry standards with which the SEC and VRA will comply. Further information regarding the applicability of legislation and standards will be provided in the ESIA Report.

Specifically, this chapter provides a relevant summary of:

- a) Ghana’s Government and Administrative Framework
- b) Ghana’s environmental and social laws and regulations deemed applicable to the Project
- c) International conventions and standards with which the Project will comply and
- d) The corporate policies of both the SEC and VRA.

### 2.1. Government and Administrative Framework

#### 2.1.1 *The Ghanaian Constitution*

Article 41(k) of the Constitution of Ghana requires that all citizens protect and safeguard the natural environment of the Republic of Ghana. As such SEC and VRA will do everything possible to safeguard the environment while pursuing its objectives.

#### 2.1.2 *Ministries and Administrative Bodies*

Ghana’s legislation is issued at the national level through Policies, Acts, Regulations and Guidelines. These are enforced by a number of administrative bodies and ministries. The key ministries and administrative bodies relevant to the project include:

- a) Ministry of Energy and Petroleum
- b) Ministry of Power
- c) Ministry of Lands and Natural Resources
- d) Ministry of Water Resources, Works and Housing
- e) Ministry of Defence
- f) Ministry of Environment, Science, Technology and Innovation
- g) Ministry of Local Government & Rural Development
- h) Environmental Protection Agency
- i) Energy Commission
- j) Lands Commission
- k) Forestry Commission
- l) Fisheries Commission
- m) Water Resources Commission
- n) Minerals Commission
- o) Ghana Ports and Harbours Authority

- p) Ghana Maritime Authority
- q) The Ghana Investment Promotion Centre (GIPC)
- r) Ghana Grid Company Limited

## 2.2. Environmental Legislation

In 1991, the National Environmental Policy (NEP) was adopted by the Ghanaian Government as a means of ensuring economic development without disservices to social and environmental development. The NEP provided a framework for the implementation of the National Environmental Action Plan (NEAP) as well as a number of other policies relating to conservation and environmental management.

### 2.2.1 The Environmental Protection Act

The Environmental Protection Act (Act 490 of 1994) establishes the authority, responsibility, structure and funding of the Environmental Protection Agency (EPA). Part I of the Act mandates the EPA with the formulation of environmental policy, issuing of environmental permits and pollution abatement notices and prescribing standards and guidelines. The Act defines the requirement for and responsibilities of the Environmental Protection Inspectors and empowers the EPA to request that an ESIA process be undertaken.

### 2.2.2 Environmental Assessment Regulations

The ESIA process is legislated through the Environmental Assessment Regulations (LI 1652, 1999) as amended (2002), the principal enactment within the Environmental Protection Act (Act 490 of 1994). The ESIA Regulations require that all activities likely to have an adverse effect on the environment must be subject to environmental assessment and issuance of a permit before commencement of the activity. The ESIA Regulations set out the requirements for the following: Preliminary Environmental Assessments (PEAs), Environmental Impact Assessments (EIAs), Environmental Impact Statement (EIS) (also termed the ESIA Report), Environmental Management Plans (EMPs), Environmental Certificates and Environmental Permitting.

Schedules 1 and 2 of the Regulations provide lists of activities for which an environmental permit is required and ESIA is mandatory, respectively. The construction of the 2x350 MW Supercritical Coal-Fired Power Plant is an undertaking which requires a full ESIA before a permit could be issued.

### 2.2.3 Environmental Guidelines

The EPA has issued formal guidance on regulatory requirements and the ESIA process. The following documents are relevant to the ESIA process and the Project and will be complied with as necessary:

- a) Environmental Assessment in Ghana, a Guide to Environmental Impact Assessment Procedures (EPA, 1996)

- b) Environmental Quality Guidelines for Ambient Air (EPA)
- c) Sector Specific Effluent Quality Guidelines for Discharges into Natural Water Bodies (EPA) and
- d) General Environmental Quality Standards for Industrial or Facility Effluents, Air Quality and Noise Levels (EPA).

### 2.3. Land and Water Resources Legislations

SEC and VRA will acquire significant portions of land for the thermal project. The acquisition of these lands as well as compensation is governed by the following legislations:

- a) The State Lands Act, 1963
- b) The Lands (Statutory Wayleaves) Act, 1963
- c) The Land Planning and Soil Conservation Act, 1953 (Act 32)
- d) The Lands Commission Act, 1994 (Act. 483)
- e) The Stool Lands Act, 1994 (Act 481)
- f) The Ghana Land Policy 1999

Out of the above the three key legislations applicable to this project are the State Lands Acts, the Stool Lands Acts and the Land Commission Acts.

The State Lands Act. 1962 (Act 125) and its amendments establish the principles for compulsory acquisition of land. After the submission of an application to acquire land, a “Site Advisory Committee” is set up in order to assess the application. The application is then assessed by the Ministry to a Land Commission, which prepare an executive instrument. Once this instrument is accepted and endorsed by the Minister, it is published in the newspapers and claims can be submitted by property owners. The valuation board estimates the corresponding compensation. Compensation is then made to the property owners and sometimes resettlement is followed.

The Stool Lands Act, 1994 (Act 481). Stool lands are defined as that which belongs to or is controlled by a stool or skin, the head of a particular community/ family, for the benefit of the subjects of that stool or the members of that community.

The Lands Commission Act, 1994 (Act 483) details the management frameworks for public and other lands and establishes a commission to assist and advise the government, local and traditional authorities on land related issues, usage and management concerns. The Act establishes the Land Commission under the Ministry Lands and Natural Resources to oversee all Land issues.

The commission comprises four divisions:

- a) Land Registration Division (Formerly Land Title Registry and the Deeds Registry)
- b) Land Valuation Division (Formerly Land Valuation Board)
- c) Survey and Mapping Division (Formerly Survey Department) and
- d) Public and Vested Lands Management Division (Formerly Lands Commission) (Commonwealth of Nations, 2012).

The Land Commission governs land acquisitions, as will be required for the Project.

Water resources in Ghana are governed by two pieces of legislation, namely the Water Resources Commission Act (Act 52 of 1996) and the Water and Sewerage Corporation Act (Act 310 of 1965).

For the purpose of the proposed project, the Water Resources Commission Act (Act 52 of 1996) is relevant here. The Act establishes a commission to regulate and manage the water resources of the Republic of Ghana. The commission is tasked with establishing comprehensive plans for the use, conservation, protection, development and improvement of Ghana's water resources and is able to grant water rights for the exploitation of water resources.

#### **2.4. Biodiversity and Wildlife Legislations**

Since the project would utilize biologically rich forest, riverine and marine environments, legislations that govern these environments will be strictly adhered to by the SEC and VRA.

The legislations which regulate biodiversity and wildlife in Ghana are:

- a) Wild Animals Preservation Act, Act 235 1964
- b) Wildlife Conservation Regulations 1971 (LI 685)
- c) Wild Reserves Regulations 1971 (LI 740)
- d) Forest Protection (Amendment) Act 2002, Act 624
- e) Fisheries Act 2002, Act 625

Section 93 of the Fisheries Act requires that the Fisheries Commission is informed of any activity with potential impacts on fishery resources and provided with mitigation strategies by proponents of the project. This is particularly important due to the services (food, income and employment) provided by the resource.

Other plans and policies exist to better manage forest and biodiversity. These include the Forest and Wildlife Conservation Policy, National Biodiversity Strategy. These legislations will be fully explained in the draft ESIA document.

#### **2.5. Pollution Control**

Pollution Control is defined through the existing environmental legislations, rather than a single overarching framework. These will be adhered to during all phases of the project

and include:

- a) Section 2(f) of the Environmental Protection Act (1994) which empowers the EPA to issue abatement notices for pollution regulation.
- b) Section 2(h) and 2(j) of the Act further enables the EPA to administer guidelines on environmental pollution and to collaborate with other bodies such as District Assemblies in controlling pollution respectively.
- c) In addition, Section 24 of the The Water Resources Commission Act prohibits polluting water resources.

## 2.6. Power Sector

The Ministry of Power is the highest executive body responsible for formulating, monitoring and evaluating policies, programmes and projects in Ghana's power sector. The National Electrification Scheme is a notable programme with the aim of extending electricity to all communities in Ghana. For achieving this, the National Energy Policy, 2000 includes a section on for the expansion of electricity production as well as its distribution and transmission.

- a) Relating to this the Government to Ghana has been pursuing the following in regards to thermal plants:
- b) Financing from the private sector for the rehabilitation and expansion of existing power plants;
- c) Completion the construction of on-going power projects;
- d) Encouragement of private sector investment in the construction and ownership of additional power plants.

Electricity generation is undertaken by the state-owned Volta River Authority (VRA) and the Bui Power Authority (BPA).

Regulations governing the supply and transmission of electricity include:

- a) The Public Utilities Regulatory Commission (PURC), Act 538 (1997)
- b) Electricity Transmission (Technical, Operation and Standards of Performance) Rules. 2008 L.I. 1934 and
- c) L.I. 1937: Electricity Regulations, 2008

## 2.7. Other Relevant Ghanaian Regulations

There are other relevant legislations which are applicable to the project and they will be fully explained in the draft ESIA document.

These are presented in the table below:

- a) Factories, Offices and Shops (Amendment) Law, 1983 (PNDCL 66)

- b) Ghana National Fire Service Act, 1997 (Act 537), s.33(b)]
- c) Ghana Building Regulations LI 1630
- d) Labour Act 2009 Act 651
- e) Labour Decree Act of 1967, NLCD 157
- f) Industrial Relation 196 Act 299
- g) Local Government Act 462 1993
- h) National Building Regulation, 1996 (LI 1630)
- i) Town and Country Planning Ordinance, 1945 (Cap 84)
- j) The Children’s Act (Act 560) of 1998
- k) Commissions on Human Rights and Administrative Justice Act (Act 456) of 1993

## 2.8. Relevant International Agreements and Conventions

Ghana is signatory to a number of international conventions and agreements and regional treaties seeking to conserve key ecosystems and natural resources and in relation to energy development, and environmental management (See **Table 2-1**).

In certain cases conventions and agreements have influenced policy, guidelines and regulations and must be considered in the impact assessment and complied with during the planning, construction and operation of this project. Also these agreements are cited in the World Bank’s key international agreements on the environment.

**Table 2-1: Relevant International Agreements and Conventions**

Name	Year Ratified
The International Labour Organisation (ILO) Fundamental Conventions related to forced labour, freedom of association, discrimination and child labour.	2011
International Covenant on Economic, Social and Cultural Rights	2000
Gulf of Guinea Large Marine Ecosystem Project	1999
Memorandum of Understanding Concerning Conservation Measures for Marine Turtles of Atlantic Coast of Africa	1999
United Nations (UN) Convention on Biological Diversity	1994
Framework Convention on Climate Change	1992
Convention of Fisheries Cooperation among African States Bordering the Atlantic Ocean	1991
African Charter on Human and Peoples' Rights	1989
Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of West and Central African Region (Abidjan Convention)	1981, ratified in 1989
Convention on Wetland of International Importance (Ramsar)	1988

Convention on the Conservation of Migratory Species of Wild Animals	1988
Convention Concerning the Protection of Workers against Occupational Hazards in the Working Environment due to Air Pollution, Noise and Vibration (ILO No. 148)	1987
United Nations Convention Law of the Sea	1982
Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention), Paris	1975
African Convention on Conservation of Nature and Natural Resources.	1968

## 2.9. International Best Practice Standards and Guidelines

To aid the decision making on provision of financing qualify for financing, finance advising as well as loans the ESIA must conform to a number of international standards. These include the IFC Performance Standards as follows:

- a) Assessment and Management of Environmental and Social Risks and Impacts
- b) Labour and Working Conditions
- c) Resource Efficiency and Pollution Prevention
- d) Community Health, Safety, and Security
- e) Land Acquisition and Involuntary Resettlement
- f) Biodiversity Conservation and Sustainable Management of Living Natural Resources
- g) Indigenous Peoples
- h) Cultural Heritage

Furthermore, the proposed project must be developed in compliance with the Equator Principles Financial Institutions' Equator Principles; consisting of the following:

- a) Review and Categorisation
- b) Environmental and Social Assessment
- c) Applicable Environmental and Social Standards
- d) Environmental and Social Management System and Equator Principles Action Plan
- e) Stakeholder Engagement
- f) Grievance Mechanism
- g) Independent Review
- h) Covenants
- i) Independent Monitoring and Reporting
- j) Reporting and Transparency

Compatibility with the IFC performance Standards necessitates compliance with the World Bank Group's Environmental, Health and Safety Guidelines (EHS Guidelines) under the following broad headings:

- a) Environmental
- b) Occupational Health and Safety
- c) Community Health and Safety
- d) Construction and Decommissioning

Industry Specific EHS Guidelines the project would comply with:

- a) EHS Guidelines for Thermal Power Plants
- b) EHS Guidelines for Electric Power Transmission and Distribution

## 2.10. Corporate Environmental Policy Statements

### 2.10.1 VRA Environmental Policy Statement

The Volta River Authority is committed to ensuring continuous improvement of environmental performance that minimizes potential impacts of all its operations on the environment, in line with the principles of sustainable development, in addition to complying with national and international environmental protection regulations.

In respect of the above, VRA will:

1. Make environmental considerations a priority in all business planning and decision-making and comply with relevant national and international environmental protection regulations.
2. Take reasonable steps to mitigate the impact of its actions with regard to the development, operation and management of its assets.

VRA will thus pursue the following specific objectives:

1. Develop and implement Environmental Management System for all its business units to :
  - I. Assess environmental impact of processes, operations and products;
  - II. Focus on pollution prevention and waste reduction;
  - III. Ensure compliance with national/ international environmental protection regulations;
  - IV. Set annual environmental targets to ensure continuous improvements;
  - V. Monitor and report on environmental performance as required the appropriate stakeholders.
2. Ensure minimum environmental impact of VRA's projects and take adequate steps to mitigate any such anticipated adverse impact as far as is practicable
3. Promote environmental awareness and individual sense of responsibilities among its employees through print material for distribution, safety

meetings and corporate website which will continue to be updated, and provided adequate empowerment and training for personnel to perform environmental jobs satisfactorily;

4. Support research efforts on materials, products, processes and pollution reduction techniques that are directly related to its operations;
5. Contribute to the development of public policy and programmes that enhance environmental awareness and protection;
6. Promote open communication on environmental issues
7. Undertake projects and programmes in collaboration with relevant agencies to preserve the Volta Lake resource, and reasonably restore/mitigate ecological imbalance caused by the creation of the lake;
8. Undertake projects and programmes to mitigate the impact on the livelihood of individuals and communities displaced or affected by VRA's development projects.

VRA shall design evaluation procedures for all processes for that fall under this policy to ensure that these processes comply. Deficiencies in the policy or in the evaluation procedure shall be addressed as required.

Each employee of VRA is charged to exercise his or her responsibility on behalf of VRA to ensure that the intentions of this Policy Statement are diligently carried out.

### **2.10.2 SEC Environmental Policy Statement**

Shenzhen Energy Group Co., Ltd is committed to conducting its operations in the manner that safeguards the integrity and sustainability of the environment in conformity with the national and international environmental quality standards for sustainable development.

The policy further enjoins the company taking the necessary measures to ensure and maintain compliance with all relevant legislation on environmental protection and health and safety of all employees.

SEC commits to ensuring harmony between increased power generation and natural ecosystem conservation. At Shenzhen Energy Group Co., Ltd. all our operational activities in promoting sustainable growth in power generation are foremost guided by sustainable environmental practices and ensuring full protection of the fragile ecology.

It is our vision to go higher in power generation while lowering Green House Gas emission intensity. Our key guiding principle is hinged on efficient and sustainable use of natural resources and conservation.

Management of Shenzhen Energy Group Co., Ltd. is vitally interested and committed to the in improving the environment and quality of life of mankind for the present and the

future.

## PROJECT DESCRIPTION

The project involves the development of an integrated 2000MW total installed capacity supercritical coal-fired power plant with affiliated coal handling terminal along the coastline of Ghana.

### 3.1. Project Background

The project is structured in two phases. This project known as the “**2X350MW Supercritical Coal-Fired Power Plant**” represents the first phase of the development. A second phase is planned, which is a further expansion of either 4 × 350MW or 2× 600MW supercritical coal-fired generating units.

The Phase I project is planned to commence in August 2016 with all related preparation works accomplished. The 2×350MW power units are to be completed and put into commercial operation from 2019 / 2020. The project is estimated to cost 1.5 billion US Dollars.

The project is being developed as contribution to the efforts in addressing the domestic power shortage in Ghana.

### 3.2. Component of the Project

The planned project is specified to have four main components identified as the coal-fired power generation units and associated facilities, coal handling terminal, infrastructure and residential facilities and outdoor area.

#### 3.2.1 The General Arrangement and Layout

##### The General Arrangement

- a) A coal handling terminal (CHT) would be situated in the south of the power plant; the coal will be transported to the coal storage yard through belt conveyor.
- b) The coal storage yard is set to the west of the power generating units.
- c) There would be two power blocks.
- d) Cooling water for the power plant would use seawater with the water intake pipeline about 1km into the sea.
- e) An ash yard of the power plant would be set 1.0 km north-west away from the power plant.
- f) A double-circuit 330kV power transmission line would be built from power plant to the existing 330kV line.
- g) A Living Quarters of the Project would be set at west side of the plant area, which is arranged near the seashore, occupying 4ha area.

**The General Layout**

- a) The power plant area layout is structured in three rows representing a coal stockyard - main power block - switch yard arranged from south to north.
- b) Auxiliary and ancillary facilities area - main power block area and construction production area are arranged from west to east; allowing for further extension eastwards.
- c) Two entrances would be created; a main entrance to the plant set in the middle of the west enclosure wall and a freight transport access set in the north enclosure wall.
- d) The natural ground elevation of the power plant is proposed to be from 0m to 27m, the vertical layout adopts terraced arrangement and the ground level of the coal stockyard would be determined as 6.00m, main power building as 8.00m, and switch yard as 13.00m temporarily. This cannot be affected by the Atlantic Ocean tidewater with the return period of 100 years.

**3.2.2 The Power Generating Plant****The Coal Handling System**

The coal handling system will be designed in accordance with 2X350MW supercritical coal-fired units, delivering pulverized coal to the boilers.

Coal unloading facilities for the coal handling terminal are two grab type ship unloaders each of capacity 1500 tons/hour. The imported coal is discharged from the ship to belt conveyor on the terminal, which is then transported to the first transfer tower on land.

One enclosed coal stockyard with a length of 435m and width of 114m would be provided on site. The capacity of coal stockyard can serve the two boilers for 30 days operation.

The coal storage yard would be provided with two bucket wheel stacker-reclaimers with boom length of 35m installed in the coal stockyard for coal blending function. The stacking capacity would be 3000ton/hour while the reclaiming capacity would be 500ton/hour. Also bulldozers and wheel loaders would be provided for ancillary operation works in coal stockyard. Additionally, water spray system will be provided in the coal stockyard for dust suppression.

The coal handling system would also have a screening and crushing system comprising of 2 x 500ton/hour capacity screens and 2 x 400t/hour capacity crushers. The size of input coal for the screen and coal crusher would not exceed 300mm and output size should not exceed 30 mm. Additionally the handling system would be fitted with electronic belt scales, chain code calibration devices, sampling devices, iron magnetic separators and lifting cranes. The raw feed coal from the coal storage area is first crushed into small pieces and then conveyed to the coal feed hoppers at the boilers.

Also water cleaning system would be provided in all transfer points, crusher houses, coal bunker bay, bunker bay transfer tower and closed conveyor galleries for cleaning of the coal handling system. The related waste water shall be collected and treated for further recycle. Ventilation, lighting and control of coal handling system would be appropriately designed to provide optimal efficiency and effectiveness.

### **Main Equipment and Thermo-mechanical Process System**

The supercritical coal-fired power generating plant comprises of two power blocks each consisting of:

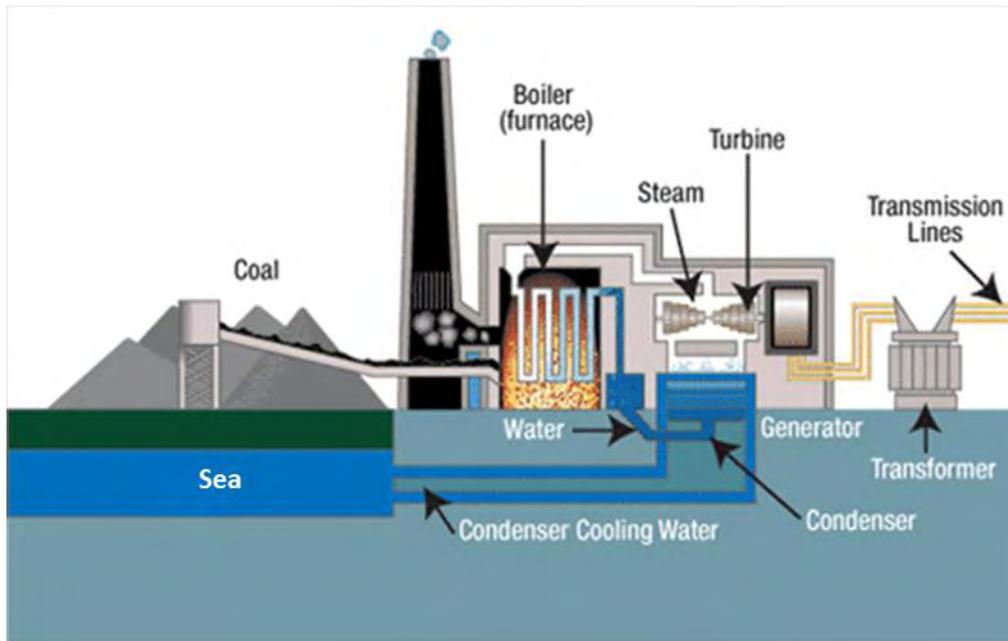
- a) a boiler based on supercritical pulverized coal technology;
- b) a steam turbine and generator unit with 350 MW rated output;
- c) a once-through circulation cooling water system;
- d) electrostatic precipitator for removal of dust in flue gas
- e) Seawater flue gas desulfurization for removal of SO<sub>x</sub> in the flue gas;
- f) Low NO<sub>x</sub> combustion

The power generation process produces electricity by burning coal in a boiler (steam generator) to heat water to produce steam. The steam, at tremendous pressure, flows into a turbine, which spins a generator to produce electricity. The steam is cooled, condensed back into water, and returned to the boiler to start the process over.

The principal source of coal fuel is considered to be South African thermal coal, the coal would be shipped at the South African Richards bay and then transport to the affiliated coal handling terminal of the power plant. However, backup coal sources can be considered from Columbia or other countries.

The coal consumption for 2x350MW coal-fired supercritical generating units is projected as an hourly consumption of 258-280 tons/hour for the two units, daily coal consumption of 6206-6734 tons/day and the annual coal consumption of 181 – 196 X10<sup>4</sup> tons/annum (calculated as annual operating hours of 7000h).

The annual operating hours are assumed from 6,500h – 7500h. Consequently, a capacity factor from 75% - 85% would be equivalent of full load operation of the plant.



**Figure 3-1: Typical Coal-Fired Power Plant**

Boiler Ignition and Combustion-Supporting fuel is a plasma ignition system adopted for boiler start-up and low-load operation assistance according to the coal specification. However, a diesel fuel system is planned as a back-up solution to guarantee the reliability and availability of the power plant.

The Boiler and Auxiliary System is a typical coal-fired boiler (steam generator) including an economizer, furnace with its steam generating tubes and super-heater & re-heater coils. Necessary safety valves are placed at suitable points to avoid excessive boiler pressure.

The air and flue gas path equipment include: forced draft (FD) fan, air pre-heater (AP), boiler furnace, induced draft (ID) fan, fly ash collectors (electrostatic precipitator or bag-house) and the flue gas stack.

Crushed coal delivered to the coal feed hoppers at the boilers is next pulverized into very fine powder and mixed with primary combustion air which transports the pulverized coal to the steam generator furnace for firing. Pulverized coal is air-blown into the furnace through burners and is ignited to burn rapidly; the resulting thermal radiation heats the water that circulates through the boiler tubes to generate steam. The saturated steam is introduced into superheat pendant tubes hanging in the hottest part of the combustion gases as they exit the furnace. Here the steam is superheated to certain temperature to prepare it for the turbine.

The steam turbine is staged in series typically comprising of a high pressure turbine, an intermediate pressure turbine and a double-flow low pressure turbine commonly

configuration in series to each other on a common shaft, with the electrical generator also on the common shaft.

Superheated steam from the boiler (steam generator) flows through a control valve into the high pressure turbine. The control valve regulates the steam flow in accordance with the power output needed from the plant. The exhaust steam from the high pressure turbine (reduced in pressure and in temperature) returns to the boiler's reheating tubes where it is reheated back to certain rated temperature before it flows into the intermediate pressure turbine. The exhaust steam from the intermediate pressure turbine flows directly into the double-flow low pressure turbine and the exhaust steam from the low pressure turbines flows into the surface condenser.

The boiler feed water used in the steam boiler transfers heat energy from the burning fuel to the mechanical energy of the spinning steam turbine. The total feed water consists of re-circulated condensate water and purified makeup water. The metallic materials are highly corrosive at high temperatures and pressures hence the makeup water is highly purified before use.

The water may be dosed with high purity Oxygen, a chemical that increase the oxidability of the water and facilitate the formation of the protective membrane on the inner boiler pipe. It is also dosed with pH control agents such as ammonia to keep the residual acidity low and thus non-corrosive. Hydrazine would be dosed to remove the remaining oxygen in the water at the start-up stage.

#### **Ash Handling System and Ash Storage Yard**

As per the coal analysis data and the coal consumption rate, the estimated ash quantity for each boiler is stated as total ash of 27.6 tons/hour comprising of bottom ash of 2.76 tons/hour and fly ash of 24.84 tons/hour (The calculation is based on bottom ash cover of 10% of total ash, and fly ash cover of 90% of total ash).

The bottom ash handling system would be a mechanical conveying system with maximum capacity 10 tons/hour. High temperature bottom ash from the boiler furnace would be discharged through the ash hopper dropping into the steel conveyor and conveyed to bottom ash bin. The bottom ash would be cooled by the cooling air, which recovers the heat to the boiler furnace. Then the bottom ash will be unloading to trucks to transport to the ash yard.

Fly ash handling system would be a dense phase pneumatic pressurized conveying system of capacity 37 tons/hour. Fly ash collected in the hoppers would be evacuated sequentially to the fly ash silo by ash vessels, piping and process controller. Compressed air for conveying the ash would be supplied by air receivers of the compressed air

system.

The fly ash silo is provided for temporary fly ash storage and would be able to store about 24 hours fly ash discharged. Each fly ash silo would be provided three unloaders beneath; one dry ash unloader for closed tank car, one wet ash unloader for open truck with ash conditioner and one stand by outlet.

The project proposes to adopt dry ash storage scheme. The primary ash storage yard is planned to satisfy 5 years storage capacity of 2×350MW generation unit. The planned ash storage area is also based on 20 years storage requirement of the Project.

The ash will be transported to ash storage yard by trucks. The estimated dry ash generation from the power plant is presented a following:

**Table 3-1: Ash Quantities**

	<b>Fly Ash (10<sup>4</sup>t/a)</b>	<b>Bottom Ash (10<sup>4</sup>t/a)</b>	<b>Cobble Coal (10<sup>4</sup>t/a)</b>	<b>Total Volume (10<sup>4</sup> m<sup>3</sup>/a)</b>
2×350MW	30.97	3.44	0.92	35.33

The Ash can be utilized for the production of building material such as cement and bricks, and also can be used for construction of embankment and road pavement.

Ghana has a characteristic weak industrial base, including the construction sector; cement and building materials mainly rely on imported inputs and consequently the prices are high. The project therefore intends to advocate the promotion of comprehensive utilization of the ash in industrial development, which will bring about good economic benefits.

### **Water Supply and Discharge Systems**

The Seawater Intake System is proposed as a scheme of "east water intake and west drainage" based on available data and integrated coal-fired power station and coal handling terminal design philosophy in order to reduce the warm discharge effect on the intake water temperature. The intake point would be situated within the port basin, isolating it from the drainage point outside the port breakwater to the west. The intake would be located at the water level -8m.

This project intends to adopt seabed water intake structures, two water intake head, two gravity water diversion channel and one cooling water pump house, using seawater corrosion-resistant reinforced concrete structure.

The Seawater Drainage System involves circulating cooling water flowing back into the shallow sea area, and parallel to the breakwater. This drainage system will adopt buried

reinforced concrete channel arranged at the bottom of the sea at -3.0m outside the breakwater.

This preliminary design would be finalized in relation to the key features, relating to the head type, location, elevation, spacing, etc. of water intake and drainage. These features would be optimized based on seawater modeling and actual contoured bathymetric chart combined with the related marine environment assessment requirement in the next design phase.

Supply of fresh water for the project (including power stations and CHT) are sourced from sea water desalination system and local main water supply from Essakyir water treatment plant. After treatment the water would flow into the industrial & fire fighting water basin, where variously arranged pumping systems send the water into the industrial water system, wash water system and fire fighting water system.

The drainage system would be separately arranged and provided for the Project. The sewage water would flow into the sewage treatment station for treatment and reuse; industrial wastewater and channel wastewater would flow into industrial wastewater treatment station, for treatment and reuse. The rain water would flow into the sea by gravity through arranged pipe.

The first-flush rainwater and sewage generated during the flushing of the wharf surface is collected through the drain (or drainage pipe) set in the wharf, conveyed to the sewage tank. After being collected, sewage should be delivered by sewage pump to the waste water treatment plant in power plant for treating before reused. The faecal sewage generated by the staff of the wharf can be directly treated by the environmentally-friendly toilet set on the wharf.

### **Wastewater Treatment System**

Waste water of the plant area mainly comprises industrial waste water, acidic & alkaline waste water, scouring water of coal handling system, domestic sewage and oil waste water. The Project would treat the various kinds of waste water as per the principle of "effluent segregation" and "multiple use of water".

An industrial wastewater treatment facility would be arranged to collect and gather all kind of industrial wastewater at site, and then treat for reuse.

Acidic & alkaline waste water from the Project would be drained into neutralization tank for treatment till the pH value become 6 to 9 before recycling.

Generally, the treatment processes of each kind of waste water follow collection through sanitary sewers and domestic sewage entering domestic sewage treatment station for treatment and recycling. Two sets of 10 tons/hour domestic sewage treatment

equipment would be used for the current project, and contact oxidation process would be adopted.

Scouring water of coal handling system is disposed by two sets of coal water treatment equipment with single output of 10 tons/hour. The scouring water enters coal water settling tank, after sedimentation and coarse separation, it enters coal water treatment equipment for recycling.

An oil-water separator with the output of 10tons/hour is used for the treatment of oily wastewater, corrugated plate liquid / liquid-phase separation technique is adopted. The oil concentration after treatment is less than 5mg/l.

### **Chemical Water Treatment System**

The Chemical Water Treatment System covers seawater desalination system, boiler makeup water treatment system, condensate polishing plant, chemical dosing system for the thermodynamic system, steam and water sampling system, cooling water treatment system, auxiliary boiler dosing and sampling system.

#### ***Seawater Desalination System***

The seawater desalination system treats seawater into fresh water. The primary water source for the Project is seawater. The treatment process is coagulation and clarification→ double-layer filter→ UF→ seawater RO. The fresh water after desalination is industrial water, fire fighting water and input water for boiler makeup water treatment system.

#### ***Boiler Makeup Water Treatment System***

Since there is continuous withdrawal of steam and continuous return of condensate to the boiler, losses due to blow down and leakages have to be made up to maintain a desired water level in the thermal cycle. For this, continuous make-up water is added to the boiler water system. Impurities in the raw water input to the plant generally consist of calcium and magnesium salts which impart hardness to the water.

Hardness in the make-up water to the boiler will form deposits on the tube water surfaces which will lead to overheating and failure of the tubes. Consequently, the salts have to be removed from the water, which is done by water demineralization treatment plant (DM). The water from seawater desalination system should be further treated for boiler feed water makeup.

The treatment process is: primary RO→ secondary RO→ EDI, the quality of the water produced can meet the requirements of the boiler.

### ***Condensate Polishing Plant***

During the process of steam generation in power plants, the steam cools and condensate forms. The condensate is collected and then used as boiler feed water. Prior to re-use, the condensate must be purified or "polished", to remove impurities (predominantly silica oxides and sodium) which have the potential to cause damage to the boilers and turbines.

Both dissolved (i.e. silica oxides) and suspended matter (ex. iron oxide particulates from corrosion, also called 'crud'), as well as other contaminants which can cause corrosion and maintenance issues are effectively removed by condensate polishing treatment.

The condensate water use medium pressure condensate polishing method. The treatment process is: 2X50% pre-filter→3X50% mixed bed. One set for each unit, and the two units use one set resin regeneration facility.

### ***Chemical Dosing System for the Thermodynamic System***

Chemical dosing can maintain the specified water quality in boiler condensate and feed water system. The two units use a single set of dosing system, which comprises of ammonia dosing device for feed water and condensation water, oxygen dosing device for feed water and condensation water, hydrazine dosing device for feed water, and chemical dosing device for closed circulating water.

### ***Steam and Water Sampling System***

Steam and water sampling system would monitor the performance and operation of the steam and water cycle of each unit. The system is an on-line monitoring system to monitor the quality of various process fluids and to provide sufficient data to operating personnel for detection for deviations from control limits so that corrective action can be taken. There would be one set steam and water sampling device and a condenser leakage detector for each unit.

### ***Cooling Water Treatment System***

Two sets of electrolyzed seawater chlorination device shall be furnished for cooling water (seawater) treatment.

### ***Auxiliary Boiler Dosing and Sampling System***

Similarly, as in thermodynamic system, the auxiliary boiler also requires dosing device and sampling equipment.

**Hydrogen Generation Station**

A hydrogen generation station shall be furnished for generator cooling mechanism.

**Transformer Oil Treatment Device**

A movable vacuum filter would be furnished for transformer oil purifying.

**Fire Fighting System**

The project adopts the policy of “prevention first, extinguish combined with prevention” to develop specialty according to process characteristics, equipment selection and arrangement based on fire prevention measures.

Fire separation and structure design of the buildings should provide effective measures to prevent the occurrence and spread of fire. The important buildings and equipment should be furnished with two or more means for fire extinguishment. For the main transformer and high transformer areas water spray fire extinguishing system would be used, and foam extinguishing system would be adopted for oil tank area. The project would adopt clean agent gas fire extinguishing system in the electronic equipment areas inside the building and engineering room.

Fire hydrant and configured portable fire extinguisher would be provided for dumper chamber, coal yard, underground coal scuttle and transfer station; head conveying coal belt would be provided with fire water curtain, coal conveying trestle and coal layer will adopt automatic water spray, raw coal bucket adopts carbon dioxide inert gas fire. A set of fire detection, alarm and control system shall be provided to the power plant.

The power plant fire fighting water network would be an independent firefighting system. Fire fighting water pump will be installed in the comprehensive water pump house, but with industrial and potable water pump using fireproof partition. Potable water & fire fighting water basin and industrial water & fire fighting water basin would be reserved. The fixed fire extinguishing system is the backbone for the fire system. One water tank truck and one dry foam combination truck would be provided for the power plant; and also a fire engine house and corresponding supporting equipment would be provided.

**Flue Gas Desulfurization (FGD)**

Seawater Flue Gas Desulfurization (FGD) technology is adopted for this project. According to the coal quality and emissions requirements, the desulfurization efficiency is temporarily designed as 86%.

The Seawater FGD system mainly consists of flue gas system, SO<sub>2</sub> absorption system, seawater supplying system, seawater recovery system and auxiliary system. The fresh

seawater in two parts, are pumped into the SO<sub>2</sub> absorber in one part and the other one into seawater recovery system. The fresh seawater is pumped into absorber from top downwards while the flue gas enters from bottom upwards. The seawater and flue gas encounter causes the fresh seawater to absorb SO<sub>2</sub> becoming acidic effluent and then flowing into seawater recovery system by gravity. The acidic effluent mixes with the fresh seawater, which is then aerated to neutralize and oxidize the seawater. The pH value of the discharge seawater into the sea is above 6.0.

### **3.2.3 The Coal Handling Terminal**

The power plant is proposed to develop 2x350MW supercritical power generation units in phase 1 and develop another 4x350MW or 2x600MW units in the second phase.

The installed capacity of phase 1, which is designed as 700MW would require 1,800,000 to 2,050,000 tons of coal per year. The demand for coal may exceed 5,400,000 to 6,150,000 tons per year at full capacity after the second phase.

Based on economic analysis of coal-transportation vessels and considering the long-term development plan, 1x70,000 DWT coal handling terminal (CHT) berth is proposed for Phase 1 operation. The berth would be expanded to 1x100,000 DWT in future to meet Phase 2 operation. In addition 1x10,000DWT Material Offloading Facility (MOF) berth is proposed for phase 1 operation.

Due to modest coal unloading and heavy cargo transportation requirements in phase 1, the approach channel and turning basin of CHT berth will be dredged to accommodate 70,000DWT class Panamax coal carriers owned by SEC; the interconnecting waters of MOF berth will be dredged to accommodate 10,000DWT heavy duty cargo carriers.

### **The Breakwater Layout**

The breakwater layout shows two separate parts comprising of the north segment and south segment. Coal handling terminal (CHT) and heavy cargo terminal of material offloading facilities (MOF) are connected by the west segment of breakwater. A belt conveyor and access road are arranged on top of the terminals and trestle, other conveyor and access road are planned at landside of coal stockyard along the rest of breakwater.

The breakwater is plotted as approximately 1756m, including 611m long North segment along west side of coal stock yard, and 1145m long South segment.

The top elevation of breakwater is +5.0m, while the wave wall is +8.0m.

### **Coal Handling Terminal (CHT) Berth Layout**

The CHT berth is designed for 70,000DWT coal carriers with top elevation of 5.0m. The

length and width of the terminal are specified as 264x 28m.

### **Material Offloading Facility (MOF) Berth Layout**

The MOF berth is designed for 10,000DWT heavy duty cargo carriers with top elevation of 5.0m. The berth length is specified as 171m and width as 28m with connected passage to the CHT.

### **Basin Layout**

The bottom elevation of CHT berth is specified as -15.9m with berth box of 65m in phase 1 for 70,000DWT coal carriers, which would be expanded to 86m in future for 100,000DWT coal carriers. The diameter of design turning circle of CHT berth is specified as 456m with bottom elevation of -16.3m in phase 1 for 70,000DWT coal carriers, which would be expanded to 500m and -16.3m in future for 100,000DWT coal carriers.

The bottom elevation of MOF berth is specified as -9.9m with berth box of 44m in phase 1 for 10,000DWT heavy duty cargo carriers. The bottom elevation of design turning basin for MOF berth is specified as -9.9m in phase 1 for 10,000DWT heavy duty cargo carriers.

The approach channel is aligned by 150° to 330° with overall length of approximately 2.55km in phase 1 for 70,000DWT coal carriers, which would be expanded to 2.75km in future for 100,000DWT coal carriers. The width of approach channel is specified as 166m with bottom elevation of -17.0m in phase 1 for 70,000DWT coal carriers, which would be expanded to 210m and -17.4m in future for 100,000DWT coal carriers.

### **Tugboats**

Two 5000HP tugboats are required due to the distance from the existing Tema & Takoradi port to the proposed port.

### **Staff**

A staff of 50 personnel would be required to operate the terminal.

### **Auxiliary buildings**

The main production buildings include belt conveyor trestle and substation.

### **Handling Process**

Considering the specific conditions of the project, grab type ship unloader is recommended for unloading the ships. Belt conveyor is adopted for horizontal transportation of coal.

The heavy cargo can be unloaded to the terminal by ship cranes onto flatbed truck to the Plant area.

### 3.2.4 Infrastructure

#### Interconnection to the Power Transmission Grid

The planned installed capacity of coal-fired power project is 2,000MW in total, 2×350MW units shall be built in phase I and expansion conditions are reserved. According to the installation scale, unit capacity and power supply scope of the power plant, the power preferred to be evacuated at 330kV line to connect in the power grid. The interconnection scheme of phase I project is preliminarily assumed as two 330kV outgoing lines from the power plant supposed to “break-in” connection on the existing Aboadze-Volta 330kV transmission line, the length of newly built outgoing lines is around 2×15km, and the conductor cross-section is 2×430mm<sup>2</sup>.

#### Electrical Connection

The generated power will be evacuated at 330kV level. Generator transformer of each unit will deliver power to the plant 330kV switchyard, by means of overhead conductors at the incoming 330kV gantry of respective generator bay.

One and a half circuit breakers connection will be adopted for the time being. Unit1 and Unit2 will be connected to different side of the bus sectionalizer of the 330kV switchyard busbar. Switchyard will have two outgoing feeders, which will be installed for phase 1 project.

### 3.3. Residential and Outdoor Area

All buildings are designed using reasonable design technique, advanced architectural concept and traditional civilization. Architectural appearance and elevation treatment would be concise, original and pleasing. The colors of architectural structures shall be light and subject to the local environment.

The architecture would further pay attention to economic soundness, environmental protection and easy maintenance during building, create a neat, comfortable and nice operation environment according to the properties such as production process, function requirements, natural conditions, building materials and building technology through optimization of several aspects like plane layout and spatial combination, so as to fully embody high quality of modern industrial enterprises and become a symbol of civilized management.

Design of the buildings would recognize cultural characteristics and be "people oriented", to create comfortable and healthy living environment with complete facilities for employees. The living quarters shall comprise of apartment building, recreation club and

Apartment building provides a total space area of 22,000 m<sup>2</sup> with 440 staffs living apartments each of 50m<sup>2</sup> area providing bathroom and natural lighting facilities. The apartment building covers public facilities, including activity room, recreation room and first aid room etc.

The recreational club provides total area of 6,000 m<sup>2</sup>. The club is divided into two major functions: (1) public activity part and accommodation part. (2) The public activity part including the activity room, the chess room, the reading room, the gym, etc.

The accommodation part would include guest room, conference room, etc. and there would be 800m<sup>2</sup> canteen provided.

Outdoor activity area would provide field facility equipped with basketball courts, tennis courts, etc.

### **3.3.1 Civil and Structure Design criteria**

On the basis of the characteristic of structural loads, the most unfavorable load combinations would be considered as design load for structural design. Principally, Chinese codes and standards will be adopted for civil design, however, it would be ensured that all design requirements conform to the Ghana Standards where required. The basic wind pressure and seismic performance will be as per actual local situation.

The principal structural materials are steel and concrete: structural steel and bolts would be sourced from china, and the material grade, performance and quality shall conform to Chinese standards. Concrete and reinforcement will be local material, and the material grade, performance and quality shall conform to Chinese standards.

The foundation type shall be decided by the geo-technological characteristic of the Site. Generally, the foundation shall rest on natural foundations, while pile foundations can also be adopted when necessary. Foundation design and allowable settlement shall conform to Chinese codes and standards.

Based on The land index for the electrical power engineering project and the outline for fossil fuel power plant construction organization, the required plant land area refers to as Table 3-2.

**Table 3-2: Required Plant Area**

	<b>Item</b>	<b>Unit</b>	<b>Area Phase 1</b>	<b>Area Planned</b>
<b>1</b>	Power Plant area	ha	24.27	59.71
<b>2</b>	Residential Quarters	ha	5.0	5.0
<b>3</b>	Ash storage yard	ha	56.7	453
<b>4</b>	Access road	ha	1	1
<b>5</b>	Rural road re-routing	ha	14	14
<b>6</b>	Construction Area	ha	16	16
<b>7</b>	Living Camp	ha	4	4
<b>8</b>	Road to ash yard	ha	4.80	4.80

## PROJECT ALTERNATIVES

A pre-feasibility study conducted to address the selection of suitable power plant technology, power unit and plant size has been completed by Shandong Electric Power Engineering Consulting Institute Company Limited (SDEPCI), and the assessment of the affiliated coal handling terminal capacity and construction was conducted by CCCC-FHDI Engineering Company Limited.

The study further involved screening of sites and evaluation, assessing the need for power with respect to local and regional demands, development of conceptual design and schedule, infrastructure and interfaces including transmission interconnection, environmental impacts, cost risk analysis and a preliminary financial evaluation to determine power sale price and financial ability as applicable.

### 4.1. Alternative Technologies

#### 4.1.1 Coal-Fired Power Plant Technology

Considerations of energy independence and balance of payments, the greater price stability and lower cost of coal compared to natural gas make coal today's preferred choice for new base load power generation.

The project prefeasibility study has reviewed coal-fired power plant technologies, particularly considering pulverized Sub-critical Coal-fired Power Plant, Supercritical Coal-fired Power Plant and Ultra-supercritical Coal-fired Power Plant.

The Sub-critical pulverized coal-fired power plant, which makes water boil to generate steam that activates a turbine, has low efficiency of about 40%.

The Supercritical (SC) pulverized coal-fired power plant operates at temperatures and pressures above the critical point of water, i.e. above the temperature and pressure at which the liquid and gas phases of water coexist in equilibrium, and have higher efficiencies – above 43%.

The Ultra-Supercritical pulverized coal-fired power plants have higher efficiencies compared to supercritical and subcritical coal-fired power plants. The power plant efficiency is rated above 45%. Ultra-supercritical technology is more appropriate for large units.

Higher efficiencies result in requiring less coal per megawatt-hour, leading to lower emissions including carbon dioxide and mercury, higher efficiency and lower fuel costs per megawatt.

Deploying high efficiency, low emission (HELE) coal-fired power plants is a key first step along a pathway to near-zero emissions from coal with carbon capture, use and storage (CCUS). HELE technologies are commercially available now and, if deployed, can reduce greenhouse gas emissions from the entire power sector by around 20%<sup>1</sup>.

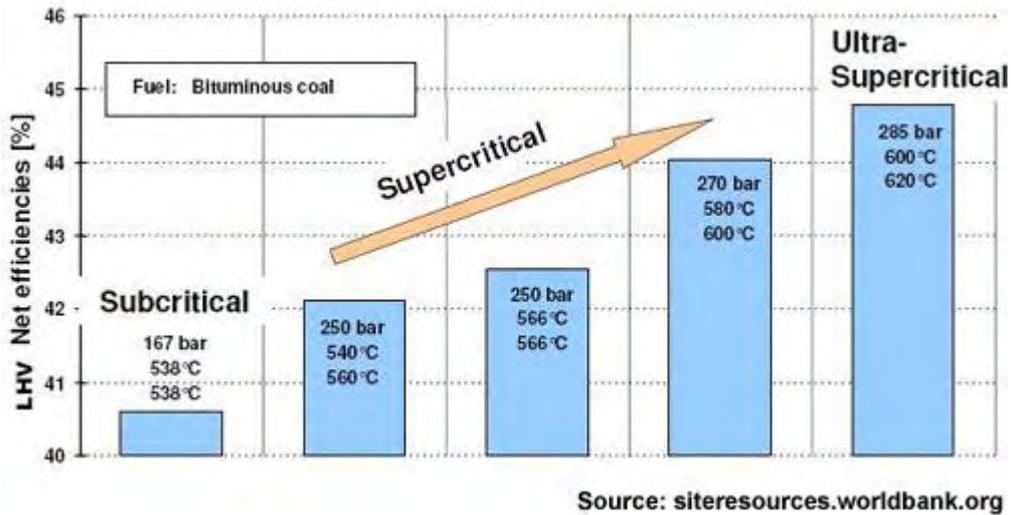


Figure 4-1: Comparison of Coal Plants - Ultra-supercritical plants have higher efficiencies than supercritical and subcritical ones

Table 4-1: Comparative Coal Consumptions and Emissions of Air blown Pulverized Coal Combustion Technologies without CCS (MIT Coal Study 2007)

CO2 Emission vs. Plant Efficiency (HHV)			
Performance	Subcritical	PC/Supercritical	PC/Ultra-Supercritical
Heat Rate Btu/kWe-h	9950	8870	7880
Gen. Efficiency (HHV)	34.3%	38.5%	43.3%
Coal use (106t/y)	1.548	1.378	1.221
CO2 emitted (106t/y)	3.47	3.09	2.74
CO2 emitted (g/kWe-h)	931	830	738

Assumptions: 500 MW net plant output ; 85% Capacity Factor

Considering the unit installed capacity of 350MW, the project proposes to adopt the supercritical pulverized coal-fired power plant as more suitable; given that ultra-supercritical technology are more appropriate for larger units. The project however would consider adopting the Ultra-supercritical technology in the phase II of the project for the 2X600MW power units.

<sup>1</sup> <http://www.worldcoal.org/reducing-co2-emissions/high-efficiency-low-emission-coal>

On the other hand, Gasification-based technologies use partial oxidation of coal with oxygen as the oxidant to produce a synthesis gas (syngas) consisting mainly of CO and H<sub>2</sub>. The gas is cleaned to remove contaminants before it is used as fuel in a combustion turbine. The exhaust gas of the gas turbine raises steam in a heat recovery steam generator (HRSG) for a steam turbine-electric generator set. The combined cycle efficiency improves through the reduced effect of the steam condenser's heat loss.

As with combustion technologies, higher efficiency results in lower emissions per MWh. The gasification process operates best under steady-state conditions. Consequently, load change conditions associated with utility electricity generation in Ghana will burden the technology.

#### 4.1.2 Flue Gas Desulfurization (FGD)

Presently, wet limestone gypsum FGD and seawater FGD are the mature applications of desulfurization technology. The Process comparison is presented as following:

**Table 4-2: Comparison of Wet Limestone Gypsum FGD and Seawater FGD**

Item.	Wet Limestone gypsum FGD	Seawater FGD
Absorbent	Limestone	Seawater
Layout space	Small	Big
Capital Cost	Low	High
Removal Efficiency	High	Low
System	Complex	Simple
Operating costs	High	Low
Byproduct	Gypsum	—
Wastewater	Desulfurization wastewater	—
Coal Applicability (Sulfur content)	Wide	<1.5%
Reliability	Less	More

Seawater Flue Gas Desulfurization (FGD) technology is adopted for this project as opposed wet limestone gypsum FGD. The project is located by the sea, coal sulfur content <1%, in this phase and therefore seawater FGD is favourable. According to the coal quality and emissions requirements, the desulfurization efficiency is temporarily designed as 86%.

Seawater FGD is simple with easy operation and management, high reliability; no limestone, gypsum and other material transport (byproduct and wastewater).

The Seawater FGD system mainly consists of flue gas system, SO<sub>2</sub> absorption system, seawater supplying system, seawater recovery system and auxiliary system.

Wet limestone Scrubber plants use limestone slurry and produce a sludge of Calcium Sulphite/Sulphate and fly ash which is deposited in a pond. Its popularity is limited by the requirements for large areas of land for sludge disposal.

#### **4.1.3 Seawater Cooling**

The coal-fired power plant may consider two basic cooling options, which are identified as Cooling Tower System and Direct Cooling by circulating seawater:

The cooling tower system involves cooling streams of water droplets by current of air created by large fans. The cooled water is then returned to the condenser to continue the cooling cycle. The cooling effect is achieved through evaporation of some of the cooling seawater. Consequently, a part of the water is lost in the process and make up is required to maintain the quantity of water.

Direct cooling by circulating seawater is achieved by continuously supplying seawater from the sea to the condenser to cool the steam from the turbine and then returned to the sea (Once through cooling).

In comparison between the use of seawater cooling tower and direct once through cooling system, the seawater cooling tower presents some disadvantages including:

- a) Lower efficiency during heat exchanges
- b) Efficiency further reduced by high temperature and humidity
- c) Causes salt spray and its environmental implications
- d) Require large water pumps and large fans on the cooling tower.

Considering efficiency, environmental consideration and economics the pre-feasibility study proposed a once through seawater cooling system for the coal-fired power plant, which offers considerable benefits in comparison with the cooling tower system.

#### **4.1.4 Coal Storage**

Coal storage facilities offer two basic alternatives identified as the open yard storage system and the close yard storage system. As the name depicts the open yard storage is not enclosed compared with the close yard storage which is significantly enclosed to prevent wind disturbance cause coal dusts flying all around.

The close yard storage is proposed for this project. Despite enclosed system is much more expensive than the open system, a close yard system is chosen over an open yard system primarily to prevent or control fugitive coal dust from escaping into the environment.

## **4.2. Alternative Fuels**

### **4.2.1 Coal Specification**

The principal source of coal fuel is considered to be South African thermal coal (with high Net Calorific Value and low sulfur content). The coal would be shipped at the South

African Richards bay and then transport to the affiliated coal handling terminal of the power plant. However, backup coal sources can be considered from Columbia or other countries.

According to current available information, the coal type used for the project will be bituminous coal and the indicative specifications are generalized as in **Table 4-3**.

**Table 4-3: Indicative Specification of Coal**

Coal Source	South Africa 1	South Africa 2	Columbia
Total Moisture (arb)	12% max	7-15%	11.4% typical
Inherent Moisture (adb)	3.5% typical	3-8%	4.5% typical
Ash (adb)	15% max	12-25%	15.5% typical
Volatile Matter (adb)	22% min	20-30%	34.8% typical
Total Sulphur (adb)	1.0% max	0.5-1.0%	0.75% typical
Net Calorific Value (arb)	5000-6000 kcal/kg	4800-6000 kcal/kg	5600kcal/kg typical

The detailed specifications of coal that would be adopted for the project will be provided in the ESIA report.

#### 4.2.2 Diesel Oil Specification

Plasma ignition system is proposed to be adopted for boiler start-up and low-load operation assistance according to the coal specification so far in the Project, taking consideration of its great operation cost saving advantage.

However, to guarantee the reliability and availability of the power plant, diesel fuel system shall also be set up as a back-up solution. The No.0 light diesel oil can be selected for ignition and combustion-supporting fuel and supposed to be delivered by road tanker to the site. Two oil tanks with a volume of 2x300m<sup>3</sup> are to be built for the storage the diesel, which will be able to meet the demand of boiler ignition and combustion-supporting.

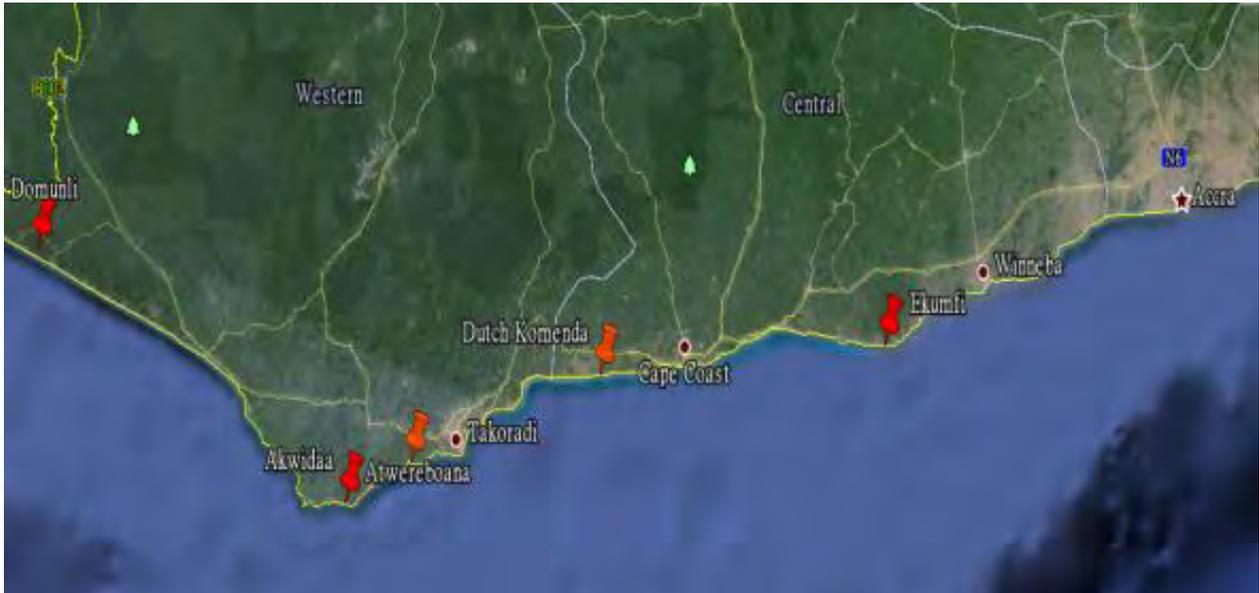
The light diesel oil specification is as following:

**Table 4-4: The Light Diesel Oil Specification**

No.	Item	Unit	Value
1	Kinematic Viscosity in Centistokes at 20 Deg.C	mm <sup>2</sup> /s	3.0~8.0
2	Pour Point:	°C	0
3	flash point (Close cup):	°C	≥55
4	Sediment by weight:	%	nil
5	Total sulphur content:	%	≤0.2
6	Water content by weight:	%	nil
7	Ash Content by weight:	%	≤0.02
8	Net Calorific Value	kJ/kg	41800

### 4.3. Alternative Site Considerations

The Project prefeasibility study considered five potential sites for the proposed integrated Power Plant and Coal Handling Terminal, with overall planned installed capacity of 2,000 MW. The five possible sites were identified as Domunli Site (Site 0), Akwidaa Site (Site 1), Ekumfi Site (Site 4), Atwereboana Site (Site 2) and Dutch Komenda Site (Site 3).



**Figure 4-2: Map of Potential Sites**

On the basis of site investigation on the 5 potential Sites 2 sites were selected for further consideration and are proposed as Akwidaa Site (Site 1) and Ekumfi Site (Site 4).

The basis of screening, evaluation and final selection of the suitable site considered the following:

- a) Well coordinated relationship between the project and the environment around the site recognizing conditions for sustainable development;
- b) Reasonable arrangement plan of relevant equipment and buildings to conserve land resources on the premise, while facilitating related O&M activities.
- c) Vertical arrangement of physical structures and facilities to reduce site earthworks and keeping cutting and filling quantities reasonably balanced.

The summary technical evaluation and comparison of the 5 sites are presented in Annex 3.

#### 4.2.3 Akwidaa (Site 1)

The Geographic Coordinates of the site are specified as: N 4°45'37.20", E 1°59'51.00". It is 30km south-west of Takoradi, 2km east of Akwidaa and more than 1.5km away from the village around. The access road of length 0.2km would connect a 6km branch road of clay pavement joining the Takoradi-Agona road.

The available land is 3km long, extending westwards to a stream and eastwards to a hill with a width of 2km from the seashore to the north with a proposed plant land of 29 X 10<sup>4</sup>m<sup>2</sup>. The site area can satisfy the construction requirements of the proposed 2,000 MW power plant, living area, ash yards and construction area. There would be no demolition within the boundary of the site. Excavation requirement is estimated as 30 X 10<sup>4</sup>m<sup>3</sup> and the filling demand is estimated as 40 X 10<sup>4</sup>m<sup>3</sup>.

The existing main features of the site are lush vegetation with many palm trees, shrubs and weeds. The terrain is relatively flat and ground elevation is from 3 to 10m. The existing land uses are predominantly for farming purposes. Other land uses are for both domestic residential and commercial facilities. The proposed area for the development of the coal-fired power plant is relatively developed with a number of physical structures and settlements especially commercial tourism facilities including beach resorts. This situation could represent more complexities and challenges in respect of land acquisition processes and resettlement requirements. A no development scenario would likely see the on-going development continuing.

According to the available marine maps, the depth contour of -10m is about 400m away from coastline and the depth contour of -16.5m is about 1600m away from coastline. There is an outward sandy coast in the west and a headland in the east. The coastline has an oblique angle to prevailing wave direction, causing significant alongshore sediment transportation from west to east. Consequently, the layout of breakwater would have significant impact on shoreline stability. Similarly, the impact of alongshore sediment transportation on the nearby channel entrance should be noticed.

The extreme highest tide level in the sea area near the site is 2.6m with Return period of 100 years; and the extreme wave height of 3.4m has Return period is 50 years. The site is not affected by the Atlantic Ocean tidewater which has Return period of 100 years. However, the site may be affected by the local watershed water catchment from north and east.

Akwidaa has been recognized as one of the coastal communities most vulnerable to climate and other stressors in the Western Region. The hydrology and oceanography of the area indicate that the coastline itself offers a distinctive marine-estuarine environment, with extensive mangroves and a lagoon called “Nana Ezile” draining the community into the sea. The lagoon divides the community into two with the Old town

(downhill) experiencing occasional flooding.

Akwidaa has an extensive network of mangrove forest due to the open lagoon “Nana Ezile” which stretches up to 2km inland. Not far from Akwidaa is the Cape Three Point Forest Conservation Reserve. The proximity and sensitivity of this forest reserve may pose questions over its long term conservation roles with a nearby power plant.

The prevailing situation within Akwidaa community shows prevalence of alongshore sediment transportation and history of major flooding especially along the shoreline. The flooding has already caused the resettlement of the inhabitants and emergence of a new community uphill referred to as Akwidaa New town. It was acknowledged that the site for the old chief’s palace currently lies in the middle of the shoreline. In this regard, construction of the coal handling terminal is expected to have major environmental impacts and implications on the shoreline stability.

The site is recognized turtle beach preservation. From the consultations, the fishermen confirmed the prevalence of sea turtle and nesting activities at the shoreline. and the existing huge mangrove along the coastal area also provides significant environmental concerns.

Access road to the site is significantly hilly and rocky and in poor condition. The road therefore presents harsh road conditions with subsequent development challenges.

For the purpose of power evacuation, a new 2x50 kilometres 330kV transmission line is required to connect the power plant to the Aboadze 330kV substation. Power evacuation is toward the east. This also presents considerable issues in relation to the expanse of land use alternative and conservation and acquisition of right of way for the transmission line and compensation arrangements.

Power supply for construction purposes can be accessed from local grid near the Takoradi-Agona Road (linear distance is 14km) while water supply would be from underground water or city water nearby. Construction material source is at the north-east of the site about 90km away and other building materials may have to be conveyed through Takoradi Port.

#### **4.2.4 Ekumfi Aboano (Site 4)**

The Geographic Coordinates of the site are specified as: N 5°12'41.44", W 0°49'51.00". The site is 78 km west of Accra and 50 km east of Cape Coast and also about 0.6 km away from adjacent village. A 0.3km access road would connect a new 2.8 km branch road developed to the north of the plant, which connects to 15km two branch roads to the north of the site linking Accra-Cape Coast main road.

The available land measures 2.0 km from west to east, and stretches 2.0 km northwards from the southern seashore with a proposed plant land of  $29 \times 10^4 \text{m}^2$ . The land area can satisfy the construction of the power plant, living area, ash yards and construction area. There would be no demolition within the boundary of the site. Excavation requirement is estimated as  $250 \times 10^4 \text{m}^3$  and the filling demand is estimated as  $260 \times 10^4 \text{m}^3$ .

The current situation shows an undeveloped land with good vegetation on the surface lying in hilly areas with elevation of 3 m to 30 m. The existing land uses are predominantly for farming purposes. Other land uses such as residential and commercial facilities are barely in existence. Natural moderate weathered granite can be taken as natural foundation bearing layers for the buildings. Zoning of the area is undetermined; however the site accords with urban planning. A no development scenario is expected to reflect increased land uses for residential and other commercial activities including tourism facilities in the near future.

The shore is characterized by rocky coastline with cliffs and it includes a small portion of sandy beach. This presents a natural coastal geomorphology suitable for the project. According to the existing marine charts, the depth contour of -10m is about 900m away from coastline and the depth contour of -16.5m is about 4000m away from coastline. The bottom substrate consists mainly of medium-coarse sand with considerable alongshore sediment transport rates showing eroded coast in general.

The site is located in the hilly area and the terrain is high-pitched. There is a small seasonal flash floods ditch with small drainage area on the west side of the site. There is no water in the ditch during dry season but gets flooded in the rainy season. To the south of the site is the Atlantic Ocean, East-west coastline is about 8m above the sea level. The extreme highest tide level in the sea area near the site is 2.6m with Return period of 100 years; and the extreme wave height of 3.4m has Return period is 50 years. The preliminary judgment is that the site is not affected by the Atlantic ocean tidewater with Return period of 100 years. However, the site may be affected by the local watershed water catchment from the north.

There exist 330kV power lines along the Accra-Cape Coast road, which is suitable for the power evacuation to the local transmission line. A new 330kV transmission line connecting the existing 330kV line at the north of the site would be required running  $2 \times 15$  km. Power evacuation is towards south, turning west and then north to connect. There is adequate space available.

Power supply for construction may be accessed from local residential network or it can be connected from the power transmission line near the Accra-Cape Coast road (linear distance is 20km). Water supply for construction may use nearby urban water supply.

Constructional materials can be obtained from existing quarries, which are situated within 40 km proximity. However, the local rock material of the site, which is granite with elevation above design requirement, represent significant source of local quarry and constructional materials for the construction works.

According to Geologic structure and evaluation of stability of the site, there is no active fault within the site. It is preliminarily considered that the plant site is located in comparatively stable area, which is suitable for building of power plant.

According to seismic effect information collected, it is preliminarily advised that the design basic acceleration of ground motion value is 0.15g, with 10% probability of exceedance in 50 years, corresponding seismic fortification intensity is 7 degree.

In conclusion, the Site belongs to a relatively stable geologic unit, and it is fit for building a power plant. The average maximum water table is more than 20m within this site. Flooding Risk Assessment indicated that Ekumfi, located in a hilly area has high-pitched terrain. The ground cover comprise shrubs. The ground elevation is about 7 to 24m. There is a small seasonal flash floods channel with small drainage area on the west side of the site; there is no water in the channel during the dry season but gets flooded in the rainy season. To the south of the site is the Atlantic Ocean. East-west coastline is about 7m above the sea level; the preliminary judgment is that the site is not affected by the Atlantic Ocean swell with a return period of 100 years. The site may be affected by the local watershed water catchment from the north.

**4.2.5 Preferred Site**

**Table 4-5: Summary Site Evaluation**

<b>Akwidaa</b>	<b>Ekumfi</b>
<b>Advantages</b>	<b>Advantages</b>
(1) The sea is not occupied. (2) A small volume of earthworks required (3) The site is relatively flat, and the natural level is proper for the plant layout. (4) Good sea depth.	(1) The native chief and people support the project. (2) The ground is stable with high load bearing strength, no pile foundation expected so far. (3) Access road to be paved and broaden is shorter, about 4km. (4) Good peripheral infrastructure and supporting condition. (5) Not obvious siltation issues. (6) 330kV transmission line is shorter. (7) Water intake pipes are shorter. (8) The coal conveying gallery is shorter.

Disadvantages:	Disadvantages:
(1) 330kV transmission line is longer. (2) The foundation adopts piles. (3) Water intake pipes are longer. (4) The access road condition is bad, 10km access way need to be paved and broaden. (5) The seashore is turtle beach preservation area (6) The coal conveying gallery is longer.	(1) A large volume of earthworks required (2) The sea will be occupied. (3) The rural environment will change.

Considering the geophysical characteristics and site advantages and disadvantages in relation to the project development of Akwidaa (Site 1) and Ekumfi (Site 4) and the associated environmental impact implications, the project has proposed situating the 2X350MW supercritical coal-fired power plant at Ekumfi (Site 4) as the preferred site for the proposed development.

The ESIA team would continue to work closely with the Project Design and Engineering team to take account of new information including information from ESIA process as and when it becomes available to review and update the status of potential impacts and mitigation measures in final project design alternatives, ensuring reducing the overall potential impact of the project.

## DESCRIPTION OF ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE

This chapter provides an overview of the aspects of the environment relating to the surrounding area in which the development will take place and which may be directly or indirectly affected by the proposed Project. This includes the Project site, the surrounding areas, the district, the region as well as the Ghanaian environment at a wider scale.

Information in this chapter was obtained from secondary sources and previous reports on the coastal portions of the Central Region of Ghana. The environmental baseline will be described in two sub-sections, the physical and the biological environment while the socio-economic baseline will be divided into socio-economics, social services and infrastructure and cultural, historical and traditional heritage.

The baseline review identifies the gaps in the existing baseline information for careful analysis to allow the project avoid repetition of work already undertaken and optimizing the collection of focused current baseline data from the project area.

A more detailed study will be done during the environmental and socio-economic baseline surveys at the full ESIA stage to provide more specific detail on the current environmental condition in the communities where the influence of the Project will be felt.

The proposed site is located in Ekumfi Aboano in the Central Region, Ghana. See *Figure 5-1* and *Figure 5-2*.

### 5.1. Physical Environment

#### 5.1.1 Climate and Meteorology

The climate of the Ghana is equatorial monsoon (Ofori and Attuquayefio, 2010) and is regulated by two air masses: the Southwest Monsoon Winds which characterize the wet season and the dry Northeast Trade Winds which characterize the dry season (Owubah et al, 2000). These air masses meet at the inter-tropical convergence zone which plays a major role in the incidence of rainfall.

According to the Ghana Statistical Service, The Ekumfi District, within which Ekumfi Aboano lies, receives an annual average rainfall ranging from 90 mm and 110 mm at its coastal areas. In general December to February and July to early September are the driest periods of the year. The major rainy season is between March and July, while the minor begins in September and ends in November. Temperatures are mild averaging from 22 to 34 °C with relative humidity of about 70 %.

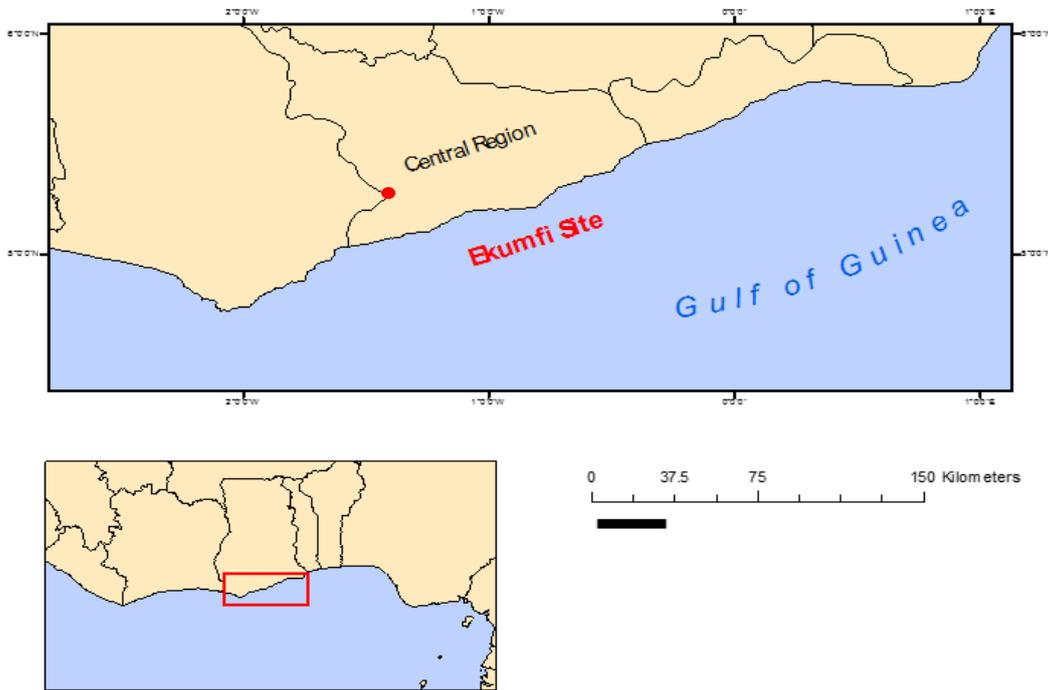


Figure 5-1: Map showing the location of the selected Ekumfi Site



Figure 5-2: Satellite imagery of the Proposed Ekumfi Site

**5.1.2 Topography and Geology**

The Ekumfi District is generally a low lying with elevations no higher than 60 m above sea level. Loose quaternary sands characterize the surface sediments of the area. “The

District consists of upper and lower Birimian rocks and intrusive Tarkwaian rocks which contain metallogenetic materials including precious metals and light metals”. Talc and diamond deposits are also present in the District. Along the coasts such as in E. Aboano are cretaceous—Eocene marine sands with thin pebbly sands and some limestone (Ghana Statistical Service, 2014). The proposed project area encompasses an extensive rocky shore about 7m above sea level and flat land stretching inland.

As stated in the Prefeasibility Report the site at Ekumfi can be described as hilly with elevations ranging from 3 m to 30 m above sea level. The boundary of the site with the Atlantic Ocean is characterized by rocky shores and cliffs as well as short fringes of sandy beach.

### 5.1.3 Seismicity

Ghana is far from the world’s major earthquake zones, but has been known to be seismically active for centuries. Earthquakes of magnitude greater than 6.0 have been recorded, however, current seismic activities has been confined to local tremors of 4.8 or less on the Richter Scale. The earthquakes have mostly occurred west of Accra in the area where the Coastal boundary fault and Akwapim fault zone meet.

It has also been suggested that this area is the most seismically active in West Africa (reviewed by Amponsah, 2004). Kutu (2013), linked the seismic activities of southern Ghana to the St. Paul’s (Axim area earthquakes) and Romanche (Accra area earthquakes) transform-fracture zone systems offshore in the Gulf of Guinea to onshore. The St. Paul’s has been inactive for some time but movement along the Romanche Transform fault and Fracture zone is active. Ekumfi Aboano is likely to be impacted by a major earthquake in the Accra region as per the Figure 5.3 below. From the geological survey done as part of the feasibility study for the area, the site was considered as an advantageous section to seismic protection of buildings.

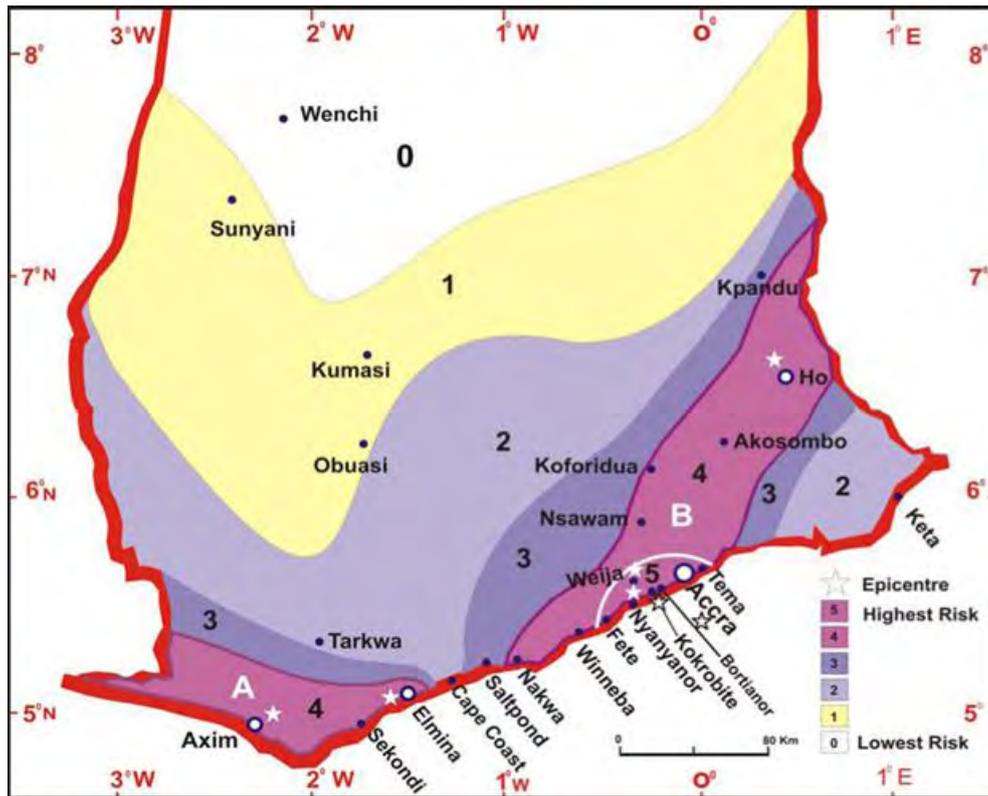


Figure 5-3: Map showing the Axim-Elmina (A) and Accra-Ho (B) seismic regions

Plot of major earthquake epicentres and the general earthquake risk-level zones of southern Ghana From: Kutu (2013).

**5.1.4 Hydrology and Oceanography**

The Ekumfi District is drained primarily by the Rivers Nakwa and Amisa which enter the Gulf of Guinea via the Nakwa and Amissano lagoons respectively. Due to its closeness to the sea, Ekumfi Aboano has most of its underground water resources intruded by salty water rendering the majority economically unavailable (Global Brigades, n.d.).

The oceanographic regime is characterized by “four distinct and predictable hydrographic seasons: the minor (December–March) and major upwelling (July–September) interspersed with periods of stratification, typically with a thermocline 30–40 m below the surface” (Wiafe et al., 2008). The Prefeasibility Report for the project predicted, based on tide observations at Takoradi, an extreme highest tide level of 2.6 m and an extreme wave height level s of 3 – 4 m with return periods of 100 and 50 years respectively at the site.

**5.1.5 Air Quality and Ambient Noise**

Ekumfi Aboano is expected to have minimal levels of noise and air pollutants due to its rural and undeveloped setting. A greater level of dust is however expected during the dry dusty Harmattan season. Likewise, it is expected that during market days for example noise levels at the trading centre would be above average levels.

## 5.2. Biological Environment

### 5.2.1 Flora

The area falls within the coastal savanna vegetation type which consists of dense scrub tangle and grass, which grow to an average height of 4.5 m. It is believed that the district was once forested, but has been systematically destroyed through centuries of bad environmental practices such as bush fires and deforestation among others. However, pockets of relatively dense forest can be found around fetish groves and isolated areas. Coconut grows very well in the area and serves as a form of protection against strong winds. In addition to the natural vegetation of the project area, Neem, palm, mangoes and the shrub bougainvillea are very prominent. Tiger nut is the main cash crop grown in the area. Other crops grown include cassava, tomatoes, pepper etc.

### 5.2.2 Fauna

Ghana's terrestrial fauna has been depleted. It does, however, comprise a diverse array of species including several of conservation concern. Current records show that there could be as many as 221 species of amphibians and reptiles, 724 species of birds, 225 mammalian species (CBD, 2001). According to an unpublished report from the Winneba Wildlife Office which is close to the proposed project site, terrestrial fauna such as Duikers, Bushbuck, Ground Squirrels, Gambian rats, African civet as well as Grasscutter can be found in the area. Birds are important species in every ecological setting, the species of birds found in the propose area include plantain eater, hornbill, Senegal coucal, Barn swallow, Nightjar, Black kite, Pied crow, Laughing dove (Unpublished report Wildlife Office, Winneba, 2015). Species of snakes, lizards, frogs, ants, butterfly, bats etc can be found in the project area.

Due to the general rocky nature of the shore found in the proposed area, marine turtles may be deterred from nesting in the area. The fishing activity in the proposed area is a rife one with fishermen targeting pelagic and demersal species. The main fish species harvested in the area include pelagics (sardenlla, mackerel, anchiovies), demersals (seabreams, snappers, grunts, mullets and groupers).

## 5.3. Socio- Economics

### 5.3.1 Administrative Structure

Ekumfi Srafa Aboano falls within the jurisdiction of the Ekumfi District Assembly, which is made up of thirty-seven (37) Assembly Members, the District Chief Executive (DCE) and a Presiding Member. The DCE is appointed by the President of Ghana with support from two-thirds of the Assembly Members. Twenty-six (26) of the 37 Assembly members are elected members and 11 are government appointees. The District has one constituency (the Ekumfi Constituency) and eight area councils namely Essarkyir, Ebiram, Ekrawfo, Otuam, Narkwa, Eyisam, Srafa (Abono) and Asaafa (Ghana Statistical

Service, 2014).

The traditional capital of Ekumfi Traditional Area Council is at Ebiram where the paramount chief of the council rules from. He is supported by a number of divisional chiefs (Ghana Statistical Service, 2014). The people of Aboano are headed by a Chief who is supported by a Queenmother and elders in administering the community. All issues especially relating to land acquisition is dealt with by the Chief/elders and the respective land owners.

### **5.3.2 Demographics**

There are approximately 52,000 people inhabiting the Ekumfi District out of which 1900 of the District's population reside in Ekumfi Aboano (GSS, 2014). The population of E. Aboano is considered youthful because approximately 55.9 % of the population is children.

In the District, females make up the greater percentage (53.8 %) with a sex ratio of 85.7 males to 100 females. This ratio is high at ages 14 years and below (103.7) and rather low in the population of age 65 years and above (49.1). Age dependency ratio is higher for males than females (111.3 and 96.3 respectively) with a combined ratio of 103. There two hundred and sixty (260) homes in Ekumfi Aboano with an average of 13 – 15 people per home (Ghana Statistical Service, 2014; Global Brigades, n.d.).

### **5.3.3 Economic Activities**

The majority of the employed population (52.3%) of the Ekumfi District work within the skilled agriculture, fishery and forestry industry. The other major occupations include service and sales as well as craft and related trade (Ghana Statistical Service, 2014). Due to its undeveloped coastal setting, Ekumfi Aboano is expected to have a greater proportion of workers in the fishing and farming sector. E. Aboano has been considered a fishing community according to the Population and housing Census, GSS 2014. The main goods obtained in the area besides fish include tigernuts, maize and cassava (Global Brigades, n.d.). Small scale salt mining is also practiced in the area (Central Regional Coordinating Council, n.d.)

### **5.3.4 Social Services and Infrastructure**

#### **Health**

Like most areas in Ghana, the major health issue of Ekumfi Aboano is Malaria. There are however no medical facilities in the community but health centers are located at Otum and Esaakyir about 10 and 30 minutes' drive away respectively. It has also been speculated that the lack of toilet facilities could result in typhoid, diarrhea, cholera and other infectious diseases (Global Brigades, n.d.).

### **Education**

Educational institutions at Ekumfi Aboano offer training at the nursery, primary and junior high stages. The town has no Senior High School. The closest Senior High School is at Esakyer, 30 minutes' drive from Ekumfi Aboano. Teacher to student ratio is 1:60 and 60 % of population is literate (Global Brigades, n.d.).

Considering the District as a whole, the majority (48.9 %) of current school attendees are at the primary stage. At this stage females represent a slightly higher proportion though overall males represent 10,845 and females 9,729 of the population being formally educated. Approximately 26 % of the school going population is either in nursery or kindergarten while 0.6 % attended tertiary institutions (Ghana Statistical Service, 2014).

### **Water and Sanitation**

Challenges faced by Ekumfi Aboano regarding water resources include both quantitative and qualitative issues. Since pipe-borne water is scarce and underground water resources are economically unavailable due to salt water intrusion, community members mainly rely on rainfall and a fresh water pond. The latter is accessible by animals and also located near human excreta making it unsafe for consumption though it serves as a source drinking water usually without treatment. Defecation is primarily open-air (Global Brigades, n.d.).

### **Roads**

The Accra – Cape Coast road runs 10 km north of the proposed site at Ekumfi to which a rural road of about 2 km connects to north of the site. There also exists an east-west rural road within the site region.

### **Cultural, Historical and Traditional Heritage**

The Fantes constitute the dominant ethnic group in the Ekumfi District. They are believed to have migrated from the Brong Ahafo Region to the Central Region. During that period a group within the Fantes (the Ekumfis) decided to settle at the present Ekumfi District. They speak Fante. The present traditional capital is at Ebiram where the seat of the paramount chief of the Ekumfi Traditional Council is located. The main festival of the District is “Ayerye” (Drumming) celebrated by most communities in the District including E. Aboano (Ghana Statistical Service, 2014).

## **5.4. Green House Gas Emissions**

Greenhouse Gases (GHG) emissions in the atmosphere venting from anthropogenic sources are considered to be partly responsible for the global warming and causing global climate change. It is recognized that the average temperature on the Earth has increased by 0.7 degree Celsius since the start of the industrial revolution.

The United Nations Framework Convention on Climate Change (UNFCCC) is aimed to disclose country level contribution to the global GHG emissions as well as provide background to analyze emissions by sources.

The principal sources of greenhouse gases emission in Ghana are identified to include agriculture, forestry, energy (fuel combustion, mobile combustion & fugitive emission), Industrial Processes and waste.

**Table 5-1: Green House Gas Emission Baseline**

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total GHG Emissions Excluding Land-Use Change and Forestry (MtCO <sub>2</sub> e)	20.02	20.80	19.03	22.25	23.19	22.99	22.73	23.77	25.59	27.53	27.34
Total GHG Emissions Including Land-Use Change and Forestry (MtCO <sub>2</sub> e)	51.15	51.98	50.23	53.58	54.25	54.24	53.95	55.00	56.88	58.89	58.84
Total CO <sub>2</sub> (excluding Land-Use Change and Forestry) (MtCO <sub>2</sub> )	7.72	7.45	6.97	7.41	8.74	9.38	8.76	10.09	11.70	12.52	12.81
Total CH <sub>4</sub> (MtCO <sub>2</sub> e)	7.68	8.26	7.86	9.18	8.99	8.69	8.92	8.86	8.99	9.57	9.32
Total N <sub>2</sub> O (MtCO <sub>2</sub> e)	4.54	5.02	4.13	5.60	5.39	4.84	4.96	4.73	4.78	5.32	5.08
Total F-Gas (MtCO <sub>2</sub> e)	0.08	0.08	0.08	0.07	0.08	0.09	0.09	0.10	0.10	0.11	0.12
Total CO <sub>2</sub> (including Land-Use Change and Forestry) (MtCO <sub>2</sub> )	38.76	38.54	38.12	38.62	39.70	40.41	39.86	41.26	42.94	43.83	44.19
Total CH <sub>4</sub> (including Land-Use Change and Forestry) (MtCO <sub>2</sub> e)	7.74	8.31	7.89	9.26	9.06	8.84	9.00	8.90	9.03	9.61	9.41
Total N <sub>2</sub> O (including Land-Use Change and Forestry) (MtCO <sub>2</sub> e)	4.56	5.04	4.14	5.63	5.42	4.91	5.00	4.75	4.80	5.33	5.12
Energy (MtCO <sub>2</sub> e)	9.45	9.32	9.00	9.65	11.02	11.74	11.17	12.54	13.94	14.50	16.30
Industrial Processes (MtCO <sub>2</sub> e)	1.03	1.03	1.02	0.97	0.98	0.98	0.99	1.00	1.30	1.11	-
Agriculture (MtCO <sub>2</sub> e)	7.72	8.50	6.93	9.45	8.94	7.98	8.23	7.83	7.91	8.94	8.36
Waste (MtCO <sub>2</sub> e)	1.81	1.94	2.07	2.19	2.24	2.29	2.35	2.40	2.45	2.49	2.54
Land-Use Change and Forestry (MtCO <sub>2</sub> )	31.13	31.17	31.20	31.32	31.06	31.25	31.22	31.23	31.29	31.36	31.51
Bunker Fuels (MtCO <sub>2</sub> )	0.41	0.41	0.41	0.51	0.50	0.54	0.57	0.64	0.66	0.84	0.98
Electricity/Heat (MtCO <sub>2</sub> )	1.97	1.76	0.67	1.21	2.42	2.63	1.91	1.71	3.10	2.72	3.18
Manufacturing/Construction (MtCO <sub>2</sub> )	0.95	0.95	1.03	1.07	1.15	1.18	1.14	1.46	1.42	1.60	1.81
Transportation (MtCO <sub>2</sub> )	3.36	3.11	3.61	3.57	3.61	3.81	3.70	4.99	5.09	5.66	6.74
Other Fuel Combustion (MtCO <sub>2</sub> e)	2.90	3.23	3.41	3.52	3.57	3.84	4.14	4.11	4.05	4.24	4.29
Fugitive Emissions (MtCO <sub>2</sub> e)	0.27	0.27	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28

## CONSULTATION

This section presents the stakeholder engagement process prior to the inception of the Scoping study and also during the ESIA Scoping study to date.

### 6.1. Objectives and Approach

The scoping phase of the ESIA identified the potentially significant environmental and social issues relating to the construction, operation and decommissioning of the proposed development to be addressed as part of the ESIA. The key issues identified during scoping are used to define the ESIA approach, to inform the design of the environmental and socio-economic baseline studies and to ensure that there is sufficient information to address all potential impacts and issues in the ESIA process.

The objectives of stakeholder engagement before and during the Scoping consultations were to:

- a) Identify potential key stakeholders;
- b) Develop consultation tools (eg Ms PowerPoint presentations, BID, the stakeholder register);
- c) Consult with key stakeholders and introduce the Project and identify key issues;
- d) Produce a Scoping Report and Terms of Reference;
- e) Disclose the Scoping Report to EPA, key stakeholders and general public; and
- f) Obtain comments on the Scoping Report from EPA and key stakeholders to inform the ESIA.

### 6.2. Stakeholder Engagement Activities (SEA)

There have been consistent consultations with various identified stakeholders during the pre-feasibility study stage of the project and the scoping study phase of the project. To date about 20 stakeholder groups have been contacted and provided with information on the VRA/SEC 2x250 MW Supercritical Coal-Fired Power Plant Project and their concerns sought. The SEA included a field work which span several months, during which the following was achieved:

- a) Stakeholder Identification;
- b) Notifications of key stakeholders; and
- c) Consultation meetings with national, state-level, local-level and traditional authority stakeholders.

#### 6.2.1 Stakeholder Identification (Mapping)

As part of consultation process, a stakeholder identification exercise was undertaken to select key stakeholder groups and organizations, based on experiences in similar ESIA in Ghana. These stakeholders were selected on the basis that they would have an interest in the Project and would also have knowledge through which to provide insight into possible issues and concerns related to the Project. In addition, further stakeholder

groups were identified through the consultation process.

The public consultation with the identified stakeholders involved three levels namely National, District and Local level consultation. The National Level consultation covered for Power Generation: EPA, Energy Commission, Ministry of Energy, GRIDCo, VRA, Forestry Commission (Wildlife Division), NGOs and Central Regional Coordinating Centre (Minister's Office).



A Stakeholder's Forum at Coconut Grove Hotel, Elmina.



Stakeholder's conference at GS Plaza, Accra

For Port Construction the National Level consultation involved EPA, GPHA, GMA, Ministry of Transport, Ministry of Fisheries & Aquaculture Development, Forestry Commission (Wildlife Division), NGOs and Central Regional Coordinating Centre (Minister's Office).

For power plant construction and port construction, the district level consultation engaged the District Assemblies.

At local level Power Generation and port construction the consultation engaged Land owners, Chiefs and Opinion Leaders of the fishermen group, the farmers group, the women's group and the youth. A comprehensive list of stakeholders consulted to date is provided in Annex 4.

### 6.2.2 Notification of Key Stakeholders

The stakeholders selected during the identification process were either consulted with via fora, face to face meetings, or via written comment. During the pre-feasibility studies, public fora were held in Accra which brought together key industry players who were informed about the proposed project. Also face-to-face meetings were held with some of the keys stakeholders to further sensitize them of the project since it is a novelty in Ghana.

At the scoping stage, meetings were mainly arranged with EPA and the local communities. A background information document (BID) was developed to further

sensitize the local communities. The BID provided an overview of the Project and also outlined ways through which additional issues and comments could be raised with VRA/SEC and the ESIA team. At the EPA, a power point presentation was made to further sensitize the Agency and sought their concerns. A copy of the BID is provided in Annex 5.

### **6.2.3 Consultation Meetings**

Generally, each of the meetings followed this general format:

- a) Introduction by the meeting facilitator, the stakeholders present VRA/SEC team and the ESIA team;
- b) Brief description of SEC Limited 's operations;
- c) Description of the proposed the VRA/SEC 2x250 MW Supercritical Coal-Fired Power Plant development and the components; and
- d) Discussion of the key issues and any information that may be relevant to the Project.

The stakeholders that participated in each consultation meeting during scoping signed an attendance register. History of consultation, notes of the consultation meetings, attendance registers, written comments and correspondence received has been collected and organized. Part of the consultation records are provided in Annex 6.

A semi-quantitative method together with professional judgment and experience was used to identify and extract the key issues raised by stakeholders during the scoping phase. A summary of these comments raised before and during the scoping consultations is as follows.

#### **Ghana Maritime Authority (GMA)**

- a) GMA explained that they regulate the marine environment by providing Security Compliance Code in accordance with the International Ship & Port Security Code (ISPS)
- b) VRA/SEC to submit the Port Plan for assessment and subsequent approval b the National Security Committee which must be endorsed by the Minister of Transport
- c) GMA also advised that they have the mandate to provide navigational aids for vessels within the Ghanaian Maritime environment as such would offer such service for a fee to VRA/SEC.
- d) GMA will assign the navigational chart to the port once GPHA gives their approval among other services.

#### **Ghana Ports & Harbours Authority (GPHA)**

- a) GPHA indicated that since the port will be unique in terms of the cargo handled and may not duplicate any port cargo being presently handled in the Ports, they do not have any objection to the building of the terminal but due process need to be followed
- b) GPHA advised that the feasibility as well as the scoping studies needs to be done comprehensively

- c) GPHA also advised on the other stakeholders to be contacted such as the Survey, Metrological, Geological and Maritime Authorities
- d) GPHA inform VRA/SEC that their services such as pilotage, towage among others are available for a fee.
- e) GPHA suggested to VRA/SEC to build the coal handling terminal at their preferred location which will fit into GPHA's ports development programme for the Central region.

**Energy Commission (EC)**

- a) The EC has no objection to the proposed project but advised VRA/SEC to use the best available technology to limit pollution.
- b) EC also informed VRA/SEC to apply for a Wholesale Electricity Supply License which will allow for generate power



Consultative meeting with Energy Commission

**Ghana Investments Promotion Centre (GIPC)**

- a) GIPC acknowledges the enormous potential benefits of the project including employment, skills development through technology transfer, foreign exchange savings etc
- b) GIPC advised VRA/SEC to register under the GIPC Act 2013 (Act 865) to enjoy incentives such as custom duty exemption etc.

**Ghana Water Company Limited (GWCL)**

- a) GWCL inform the VRA/SEC that Ekumfi Aboano and its environs receive water from the new Essakyir Water Treatment Plant that currently operates only 10% of its installed capacity of 14400m<sup>3</sup>/d.
- b) GWCL will conduct a technical assessment to determine the feasibility of supplying water to the proposed plant
- c) GWCL requested for a joint site visit to be acquainted with the project location

**Environmental Protection Agency (EPA)**

- a) EPA requested for a site visit to be acquainted with the location

- b) EPA suggested to VRA/SEC to look into different coal-fired power plant technology in generating electricity
- c) VRA/SEC need to provide to the Agency the characteristics of the coal to be used and the fly ash
- d) EPA cautioned VRA/SEC to critically assess the siting of the plant since the current location is only 0.6km away from the nearest village. Modeling need to be done to determine the extent of the ground level concentration of flue gas emissions as well as monitoring in the nearest village.



Presentation to EPA



Meeting with GRIDCo

**Chief and Elders of Ekumfi Aboano**

- a) The issue of disposal of chemical waste into the marine environment
- b) The effect of the exclusion zone round the coal handling terminal on the fishing activities
- c) Compensation for lands acquired
- d) The effect of blasting during construction and its effect on the building and also health of the people
- e) Social benefits such as ready electricity, clearing of rocks to aid fishing etc.
- f) Project will provide alternative source of employment for youth in the community
- g) Effect of breakwater construction on the shoreline including erosion and flooding



Consultative meetings with the Chief, Elders and the people of Ekumfi Aboano

### 6.3. Scoping Notice

According to the requirements under the EIA process in accordance to the Regulation 15 (1) of LI 1652, the Administrative procedure for scoping exercise required that the public is adequately and appropriately informed.

Accordingly, notices are issued to relevant ministries, departments and agencies including Assemblies. Furthermore, advertisement is published in at least one of the national newspaper and local newspaper if any.

Consequently, the project is publishing a scoping notice in the Daily Graphic Newspaper and further pasted the notice at appropriate locations including the project site and adjoining facilities, within the communities and the premises of the District Assembly in the absence of local newspaper.

These locations are identified to include the following

- Ekumfi District Assembly (Notice board)
- Etibedu Palace (Delivered to the Chief)
- Aboano Palace ( At the entrance)
- Hotel Facility at Aboano (Electric pole at the entrance of the hotel premise)
- Aboano Village (Electric pole within the community)
- Redemption International School, Aboano (Electric pole within the school premise)
- Kuntankure settlement (Electric pole within the vicinity)
- Otuum (Assemblyman’s office notice board)

Copy of the notice is attached as Annex 7.



At the Aboano Palace



At the Aboano Village



At the Hotel Facility

## IDENTIFICATION, ANALYSIS AND EVALUATION OF IMPACTS

The chapter presents the methodology for identification and assessment of potential impacts of the project on the identified environmental receptors. Two principal receptors are considered and are identified as marine ecology and terrestrial ecology. The marine and terrestrial receptors would include the physical environment, the biological environment including related livelihood, wildlife and the Communities, Social Groups and Individuals.

The methodology for identification and assessment of related Project impacts adopted by the Project is a contemporary approach to impact assessment process, which places emphasis on reduction of potential adverse impacts and optimizing potential benefits through appropriate design measures.

An impact is considered as “any change to the physical, biological or social environment, whether adverse or beneficial, wholly or partially resulting from the Project activities, facilities, products or services”.

The project has therefore prioritized the most significant or critical impacts and evaluated design options to minimize the potential impacts. Consequently, defining the Project features and designing Project components; identifying all the potential impacts arising from the project, evaluating the standard, recognizing industry mitigation options and where needed specific impact mitigation measures to minimize the identified potential impacts.

The remaining potential impacts may be residual impacts and would be categorized as low, medium and high based on intensity or level of significance in relation to the magnitude, extent, duration, severity, probability, frequency and reversibility.

The potential impact would be identified through baseline assessment carried out in specific relations to the envisaged project activities and processes at each phase of the project. The potential environmental and social impacts resulting from each activity from the preparatory phase through construction, operation to decommissioning phases of the project would be assessed.

The criteria for assessing the significance of impact consider:

- a) The likelihood of exceeding project standards in relation to environmental quality and the National Environmental Quality Guidelines
- b) Impact affecting protected areas, valuable resources including nature conservation areas, rare or protected species, protected landscapes, historic

features, livelihoods, important sources of water supply and other key ecosystem services

- c) Conflict with the Corporate Environmental Policy and Practice.

Impacts on receptors can be varied and can be considered as negative, positive, direct or primary, indirect or secondary and cumulative, short term, long term and permanent. The importance and sensitivity of the receptors is defined by its relevance to its local, national, regional and international designation, its importance to local or wider communities, ecosystem function and economic value. The assessment would take into account the likely response of the receptor to change and the ability to adapt to and manage the effect of the impact.

The magnitude of potential impact is defined by the dimensions of the predicted impact including:

- a) The nature of change;
- b) Its size, scale or intensity;
- c) Geographical extent and distribution;
- d) Duration, frequency and reversibility.

Review and identification of potential impacts and their significance have been based on analytical review of operational processes and resources demands and requirements. Particular attention is also given to alternative considerations and best available technologies. Consideration of impact included potential ecological changes, environmental health impacts, occupational health and safety impacts, noise and air quality impacts as well as socio-economic impacts, greenhouse gas emission and global climate change.

The project is expected to comply with the relevant National, Regional and International legislation. Emissions and discharges are expected to meet the Ghana National Environmental Quality Guidelines Standards and related requirements. Moreover, the flue gas emission of the power plant will also meet the Thermal Power Guideline for Pollution Prevention and Abatement of the World Bank Group and Environmental Health and Safety Guideline for Thermal Power Plants (2008) of International Finance Corporation of the World Bank Group. The structure of the ESIA would also conform to the Guidelines from the World Bank (2007) (Operational Directive, 2007) .

**Table 7-1: Flue Gas Emission Standard**

Standard		National Environmental Quality Guideline (NEQG)	《Thermal Power Guidelines for New Plants》 Pollution Prevention and Abatement Handbook WORLD BANK GROUP Effective July 1998	《Environmental, Health, and Safety Guidelines for Thermal Power Plants》 International Finance Corporation World Bank Group December 19,2008.
Pollutant				
Smoke		Ringlemann No.2	/	/
Solid Particles (mg/m <sup>3</sup> )		200	50	50
SO <sub>3</sub> (mg/m <sup>3</sup> )		120	/	/
SO <sub>2</sub>	Concentration (mg/m <sup>3</sup> )	/	2,000	200—850
	Amount (tpd)	/	Total sulfur dioxide emissions from the power plant or unit should be less than 0.20 metric tons per day (tpd) per MWe of capacity for the first 500 MWe, plus 0.10 tpd for each additional MWe of capacity over 500 MWe. (120 tpd) for 700MW	/
Fluorine Compounds (mg/m <sup>3</sup> )		100	/	/
Hydrogen Chloride (mg/m <sup>3</sup> )		200	/	/
Chlorine (mg/m <sup>3</sup> )		100	/	/
Hydrogen Sulphide		5 ppm	/	/
NO <sub>x</sub> (mg/m <sup>3</sup> )		1000	750	510
Carbon Monoxide (mg/Nm <sup>3</sup> )		1000	/	/

The potential environmental impacts and implications of the development of 2X350MW supercritical coal-fired power generation plant with affiliated coal handling terminal would occur from the activities during pre-constructional, construction, operation and decommissioning phases of the project. Consideration is given to the source, nature and significance of the environmental impacts and possible mitigating measures.

### 7.1. Pre-construction Phase

The preconstruction activities would involve site investigation activities involving drilling and testing of sample ground materials for geological and seismic investigation. Furthermore the activities would involve transportation of testing equipment and materials.

#### 7.1.1 Impact of Terrestrial Ecology

The key environmental concerns include noise, vibration and dust generation, which would impact on the terrestrial ecosystem.

### **7.1.2 Impact on Marine Ecology**

The key environmental concerns include noise and vibration, which potentially would cause disturbance within the marine environment.

## **7.2. Construction Phase**

The construction activities would involve site preparations including, blasting, clearing, cutting and filling earth works. Furthermore, the activities would include construction of structures and civil works to accommodate power plant and machinery, ancillary infrastructure including roads and drainage system, residential facilities and coal handing terminal. The phase would also involve installation of power plant, machinery and equipment, transportation of materials and machinery and equipment as well as operation of construction machinery.

### **7.2.1 Impact on Terrestrial Ecology**

#### **Impact on Air Quality**

The construction phase is expected to have significant impact on the ambient air quality due to the site clearing, blasting and material evacuation activities. Movement of trucks and heavy duty constructional machines would contribute to gas emissions and dust generation. The main concerns relate to particulate matter, carbon monoxide, sulphur dioxide and nitrogen dioxide levels within the project area due to exhaust fumes and dust.

The dust generated could also settle on leaves and therefore influence photosynthesis function of the plants close to the project site and consequently the productivity of crops. In addition, the emissions could be significant to affect the health of workers.

#### **Noise Impact**

The ambient noise level is expected to increase considerably beyond the baseline value primarily due to blasting activities, construction activities and movement of vehicles to and from the project site. Construction activities would include hammering, blasting, drilling, welding, excavation of materials and operation of construction machines.

#### **Waste Water Generation**

The main sources of waste water are identified to include domestic sewage.

#### **Solid Waste Generation**

Solid waste generation may result from construction debris, cleared vegetation, and excavated earth. The solid wastes would also include packaging materials like cartoons, wooden casings, pallets, food containers and wrappers. Also food leftover from the

construction workers would contribute to the sources of solid waste generation. It is anticipated that there would not be large quantity of excavated material for disposal as filling demands are expected to balance excavation and cutting requirements.

### **Impact on the Ecosystem**

Construction of power plant, coal yard, ash storage yard and auxiliary facilities including residential facilities, roads, power evacuation grid lines, power supply lines etc. would contribute to clearing expansive vegetation area. Currently, the proposed site is covered with lush vegetation, once the power plant is built, the site will be replaced by buildings and structures and the landscape will be changed significantly.

The impact on plants during construction phase is potential lost of vegetation resulting from land clearing and leveling, which would destroy the original vegetation. However, the plants are not rare species, so only the quantity will be reduced and not extinct, consequently the impact would be partial, and therefore may not effectively cause regional ecological damage.

However, the potential impact on animals may not be necessarily significant as the animals around the site would be frightened by the activities of construction and move further away into nearby bushes.

### **Traffic Impact**

Heavy duty vehicles and trucks carrying building materials to and from the project site during construction, may affect traffic flow on existing access roads.

Heavy equipment of 350MW coal-fired power generation unit mainly including boiler structural girders, STG stators and rotors, main transformer etc imported principally from China would be transported to the affiliated Material Offloading Facility. The units would then be transferred to flat transporters at the project site and transported to the to the erection site. This operation is not expected to have any potential impact on the traffic in the area

### **Occupational Health and Safety Hazards**

Land preparation and movement of vehicles and machinery would generate dust and noise that could lead to respiratory problems and hearing lose respectively. Accidental tipping of construction materials and tools, use of power tools and accessories, falling gadgets, cuts from sharp objects as well as the inhalation of exhaust fumes from vehicles and equipment could cause potential harm to health of especially construction workers and neighbouring communities.

### **7.2.2 Impact on Marine Ecology**

Construction activities would involve the development of a coal handling terminal and affiliated Material Offloading Facility and installation of the once through cooling system. These activities could have potential impacts on the marine ecology and especially marine habitat and shoreline stability.

The marine construction works within the marine environment would involve blasting, dredging, filling and disposal of dredged material and sediment, which could cause sediment released to the surrounding marine environment and well as changes in marine water characteristics.

#### **Water Pollution**

Dredging and construction of the basin, channel and hydraulic structures would produce suspended solids, which potentially could cause pollution of the seawater environment.

Furthermore, production waste water from the construction operation on shore including waste water from flushing construction machinery and domestic sewage from construction workers could be discharged into the sea and may potentially contribute to polluting the seawater.

#### **Impact on Air Quality**

Construction works at sea would generate exhaust gases from the machines and equipment used during the construction operation. The exhaust gases may contribute to air pollution sources.

#### **Noise Pollution**

The operation of the construction machinery and equipment could contribute to the noise pollution sources. It is expected that various construction machinery and transporters would be widely used during the construction operation and could potentially generate considerable noise.

#### **Solid Waste Pollution**

The principal solid waste generated would include dredged silt/sediments, construction waste and domestic waste. It is expected that the operation would produce significant dredged silt.

### **7.3. Operational Phase Impacts**

The operational phase involves the operation of the coal handling terminal and affiliated Material Offloading Facility; the operation of the 2X350MW supercritical coal-fired power plant and the ancillary facilities and the running of the residential facilities.

Preliminary review of the operational requirements and activities identified the key potential impacts on the two principal receptors to include air quality, ambient temperature, ambient noise, vibration, waste disposal and health and safety issues. Other potential impacts include social and economic impact.

### 7.3.1 Impact on Terrestrial Ecology

#### Impact Air Quality

The primary potential source of air pollution is the coal dust and emissions from the coal-fired power plant, which may include flue gas comprising of carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>) and oxides of nitrogen (NO<sub>x</sub>) and fly ash.

Environmental concern relating to flue gas emission is the ground level concentration of pollutants including Suspended Particulate Matter (SPM), carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>) and oxides of nitrogen (NO<sub>x</sub>).

The operation of heavy trucks and equipment could also be potential source of emission of exhaust fumes and dust particulate.

#### Impact on Aquatic Ecology

The operation of the power plant is not envisaged to impact any significantly on surface water as no surface water is sited close nearby the plant proposed site.

#### Noise Impacts

Significant noise levels could result from the operation of the power plant, moving trucks and heavy duty machinery including offloading facilities and bulldozers. Transformers in the switchyard could also generate considerable noise.

**Table 7-2: Manufacturer’s Specifications of Equipment Sound Level**

Equipment	Sound Level (dBA)
Turbine	90
Generator	90
Crusher	95
Medium Speed Mill	90
Primary Air Fan	95
Forced Draft Fan	100
Induced Draft Fan	90
Aeration Fan	90

Air Compressor	95
Transformer	75
Circulating Water Pump	90

### **Solid Waste Pollution**

Fly ash would be the primary solid waste from the operational processes; the ash and slag generated from the coal-fired power plant are only temporarily. Consequently, fugitive fly ash may cause pollution to the surrounding. Ash and slag generated from the coal-fired power plant would be stored only temporarily.

### **Hazardous Waste**

Once the ash is soaked by rainfall, harmful element in ash may seep into the underground water, resulting in significant impact implications on the ground water.

### **7.3.2 Impact on Marine Ecology**

The operation of the coal handling terminal and the power plant with the once through cooling system and associated facilities could have considerable impacts on the marine ecology and especially the marine habitat.

### **Seawater Temperature**

The seawater once-through cooling system would create temperature rise zone around the outfall, which may affect the marine area especially marine culture. The circulating cooling sea water and discharges from seawater FGD gain considerable temperature and would be drained out of the plant. These could cause the rise in seawater temperature.

### **Seawater Pollution**

The primary sources of seawater pollution are seawater from the FGD process and seawater from the desalination process.

Seawater Flue Gas Desulfurization (FGD) system uses seawater for SO<sub>2</sub> absorption mechanism. The seawater could potentially gain additional temperature rise and cause traces of ash wash down.

Seawater effluent from the desalination process would have higher concentration of salinity and may cause potential pollution.

Another important potential source of seawater pollution is the possible spillage of oil from the operation of ships transporting coal and other materials and calling at the affiliated port facilities.

### **Noise Level**

The potential noise generation sources expected to influence the marine environment are identified to include the high speed moving parts of the ship unloader and noise from the operation of the vessels calling at the coal handling terminal and material offloading facilities. The ships could generate considerable noise from the operation of their engines and berthing processes. Furthermore, the operation of the generating plant and ancillary facilities may contribute significantly to noise levels in the marine environment.

### **Impact of Effluent**

Waste water generation sources include water cleaning system provided at the coal transfer points, crusher houses, coal bunker bay, bunker bay transfer tower and closed conveyor galleries for cleaning of the coal handling system. The rain water would flow into the sea by gravity through arranged pipe.

Additional sources of waste water include domestic sewage from the operation of the harbour, industrial waste water including concentrated seawater from desalination plant, discharges from seawater FGD and oil wastewater. Considerable amount of waste water generated from these sources and could be discharge in the seawater.

Seawater discharged from the cooling system would have higher concentration of chlorine due to the seawater chlorination for cooling water (seawater) treatment.

In the FGD process, seawater and flue gas encounter causes the seawater to absorb  $\text{SO}_2$  becoming more acidic effluent, which is further aerated adjusting the pH to become more neutral (The pH value of the discharge seawater into the sea will be above 6.0). The seawater then flows into seawater recovery system by gravity and mixes with the fresh seawater from the condenser and returns to the sea.

### **Fire Hazard**

Potential sources of fire include gas leakage from the hydrogen generation plant and generator cooling system, oil spill and leakage from the transformer cooling system, sealing oil system, lubricating oil system and light diesel oil storage for the boiler back-up start fuel.

#### **7.3.3 Occupational Health and Safety**

Operation of the power plant and affiliated facilities may cause dust and noise nuisance to the worker and could lead to respiratory problems and hearing lose respectively. Additionally, ground level gas concentration may be significantly high and could cause nuisance to the worker.

#### **7.3.4 Socio-Economic Impact**

The project would create direct or indirect employment generation with employment opportunities for both skilled and unskilled labour, enhance skills development and good localization opportunities. Furthermore, the project would contribute to providing meaningful job opportunities for the locals within the local communities and economic empowerment for the surrounding communities.

The project would also provide additional electricity to the national grid; contributing to meeting electric power shortfall in Ghana and promote local economy development while stimulating the development of related industries such as manufacturing, transportation and commerce.

The project would also contribute to the foreign direct investment inflow and contribute directly and indirectly to national revenue generation and export.

Furthermore the project would create Immigration and resultant demographic changes in the local communities; and could result in cultural changes including possible conflict arising from immigration and tourism issues.

Additionally, the project would create provisions for infrastructure development such as roads, schools and health facilities; impact on the potential land use in the area and also boost local economy.

#### **7.4 Decommission Phase**

Impact identification at the decommissioning operation would be discussed in the ESIA.

## IMPACT MITIGATION

Mitigation measures would consider actions or systems used to prevent, eliminate, reduce or compensate for impacts that have been identified. The mitigation could be inherent in design specifications or proposed during ESIA process to address impacts during project construction and operation based on the technical and financial feasibility and cost-effectiveness of the means of mitigation.

Generally, a hierarchical mitigation options would be considered including:

- a) Avoiding at source – removal of source of the impact
- b) Abating at source – reducing the source of the impact
- c) Attenuating – reducing the impact between the source and the receptor
- d) Abatement at the receptor – reduce the impact at the receptor
- e) Remedy – repair the damage after it has occurred
- f) Compensation/offsetting – replacing in kind.

### 8.1. Pre-construction Phase

Impacts identified during the pre-construction phase are reckoned to be insignificant.

### 8.2. Construction Phase

#### 8.2.1 Terrestrial Ecology

##### Impact on Air Quality

The construction area would be fenced to contain dust emission as well as the noise level. Tarpaulin covers will be provided for all aggregate materials being transported from quarries to project site.

##### Noise Impact

The construction area would be corded off to contain the noise level, Ensure constructional machines and equipment have effective silencers and workers would be provided with protective wears including ear plug where necessary.

##### Occupational Health and Safety

Workers would be provided with appropriate personal protective gears.

#### 8.2.2 Marine Ecology

Construction activities are expected to have significant impact on the marine environment, the resulting change in the physical environment due to channel, basin and

breakwater construction would impact on the benthic ecosystem, which could affect marine habitat and shoreline. The ESIA would critically investigate the situation to identify appropriate mitigation measures to ensure minimal impact.

### **Water Pollution**

Production of suspended solids, especially sediments are expected to pollute the seawater considerably, however this is only expected to be temporary.

Production waste water from the construction operation and domestic sewage would be appropriately treated before discharge into the marine environment.

### **Noise Pollution**

The operation of the construction machinery and equipment as well as marine transporters would be effectively maintained and appropriately managed to reduce noise levels.

### **Solid Waste Pollution**

The principal solid waste generated would include dredged silt/sediments, construction waste and domestic waste would be disposed of appropriately.

## **8.3. Operational Phase**

### ***8.3.1 Terrestrial Ecology***

#### **Waste Water**

The main sources of waste water identified to include domestic sewage, coal waste water, industrial waste water and oil wastewater will be treated separately and then reused.

Circulating cooling seawater, concentrated seawater from desalination plant and discharges from seawater FGD will be drained out of the plant.

#### **Air Pollution**

Coal stockyard will be enclosed to effectively prevent fugitive coal dust escaping into the atmosphere.

Electrostatic Precipitator (ESP) would be used for the efficient removal (>99.55%), ash dust under 50mg/m<sup>3</sup> at outlet of the stack.

Seawater Flue Gas Desulfurization (FGD) system will be considered for the time being, with the desulfurization efficiency not less than 86%. The SO<sub>2</sub> emission would not be more than 200mg/m<sup>3</sup> at outlet of stack.

Boiler is designed with low NO<sub>x</sub> combustion, NO<sub>x</sub> emission will be not more than 350mg/m<sup>3</sup> at outlet of stack.

Flue gas will be finally emitted through a common stack with preliminary height of 180m, which will provide effective dispersion of pollutants and therefore reducing ground level concentration and impact of pollutants on the ambient air.

### **Noise**

The specification of noise requirements for specific equipment from the manufacturers would be considered and where necessary, acoustic absorbent, mufflers, and other noise abatement system will be considered to control the noise level.

Mufflers would be incorporated at steam vents of boiler. Additionally the operation and maintenance would be strengthened during operation of the power plant, to reduce emission frequency of boiler; avoid emission at night when required, so as to reduce the noise influence on surroundings.

The pipeline and air duct design parameters would be considered to improve the flow field of air and fluid transportation to reduce the air power noise and prevent vibration impact and vibration noise.

The plant design would consider reasonable overall planning for the plant area; arranging high-noise equipment far from the areas with high noise sensitivity.

Green belt plantation would be developed appropriately in higher noise areas to reduce noise level. In addition, the project would plant shrub along roadsides, around the main powerhouse and nearby other noise sources as required to improve noise reduction function.

Generally, the proposed plant site is a considerable distance away from the nearby villages and consequently it is expected that the power plant contribution to the noise disturbance in the villages would be low in not insignificant.

### **Solid Waste**

The ash would be transported to ash storage yard, where it would be rolled and compacted in time. Timely watering of the surface of ash body is necessary to avoid fugitive dust.

### **Hazardous Waste**

Mitigating occurrence of harmful elements in soaked ash seeping into underground water the project would develop anti-seepage scheme at the ash yard based on conventional prevention practice. A composite geo-membrane (polyethylene complex geo-textile) shall be set on the bottom of the ash yard and inside the slope of the dam. The effect of composite geo-membrane should be equivalent to the anti-seepage performance as 1.5m thick clay soil with permeability coefficient of  $1.0 \times 10^{-7}$  cm/s.

The ash yard can be changed back to farmland by returning soil covering on top of the ash after ash level reaches the design level.

In order to mitigate pollution impact by fly ash, the project would develop 10m wide green belt composed of local trees and grasses set around ash storage yard. The green belt would also serve to beautify the immediate surrounding of the ash storage yard.

Ash and slag generated from the coal-fired power plant are only temporarily stored in the ash yard, utilization of the ash and slag is very important for sustainable management of the waste ash in Ghana. Presently, ash utilization is alien to the local cement production and construction industry and would require concerted efforts to advocate and promote the use and benefits in Ghana's construction sector.

### **Occupational Health and Safety**

Workers would be provided with appropriate personal protective gears. Furthermore, Ventilation, lighting and control of coal handling system would be appropriately designed to provide optimal efficiency and effectiveness within the operating environment.

The project would consider safety and risk design of the plant and affiliated facilities to review hazard assessment and analysis of the overall installation to demonstrate risk acceptability and safety level of the plant. The review would include:

- Hazard and Operability (HAZOP) review,
- Hazard Identification (HAZID) review,
- Quantitative Risk Assessment (QRA)
- Safety Integrity level (SIL) study
- “as low as reasonably practicable” ALARP study
- Fire & Explosion Study Report

### **8.3.2 Marine Ecology**

#### **Seawater Temperature**

Seawater effluent discharges into the sea have the potential of increasing the seawater temperature significantly. A thermal plume dispersion modeling would be conducted to predict the permissible size of the mixing zone and the effect on sea organisms.

The position of outfall will avoid sensitive areas and the influence of thermal water on the ocean will be determined by further study based on the result of thermal modeling taking into consideration the size, hydraulic and hydrological data of the receiving body of water and the design and siting of the wastewater outfall.

### **Seawater Pollution**

Emergency plan including ship oil spillage would be developed for the operation of the wharf.

### **Noise Level**

Measures shall be taken to ensure that the high-speed moving parts of ship unloaders are appropriately maintained to mitigate noise. The noise control level for ship unloader shall be less than 90dB in work area and less than 85dB in its electrical room, less than 65 dB in its cab.

### **Waste Water**

Waste water generated from the water cleaning systems and industrial operations are treated for reuse and consequently there would be minimal discharge into the marine environment.

The drainage system would be separately arranged and provided for the Project. The sewage water would flow into the sewage treatment station for treatment and reuse; industrial wastewater and channel wastewater would flow into industrial wastewater treatment station, for treatment and reuse. An industrial wastewater treatment facility would be arranged to collect and gather all kind of industrial wastewater at site, and then treat for reuse.

The rain water would flow into the sea by gravity through arranged pipe. The first-flush rainwater and sewage generated during the flushing of the wharf surface is collected through the drain (or drainage pipe) set in the wharf, conveyed to the sewage tank. After being collected, sewage should be delivered by sewage pump to the waste water treatment plant in power plant for treating before reused.

The faecal sewage generated by the staff of the wharf would be directly treated by the environmentally-friendly toilet set on the wharf

## MONITORING

### 9.1. Ambient Air Quality Monitoring

Periodic monitoring of the ambient air quality would be instituted. However, on site monitoring would be established based on the outcome of the modeled emission dispersion characteristics and outfall.

### 9.2. Emission Monitoring

Continuous emissions monitoring equipment will be installed on the stack for real time monitoring and also establish a monitoring station within the near village.

### 9.3. Effluent Seawater Quality and Temperature Monitoring

Periodic monitoring of the basic physico-chemical characteristics of effluent seawater including heavy metal pollutants and seawater temperature would be instituted.

### 9.4. Ambient Noise Monitoring

Ambient noise level would be monitored periodically.

## TERMS OF REFERENCE FOR ESIA

### 10.1. Chapter Overview

This chapter provides the proposed Terms of Reference for the ESIA and is structured as follows:

- Next steps required to complete the ESIA process
- Proposed baseline studies
- Proposed structure of the ESIA Report

### 10.2. Next Step to Complete the ESIA

After submission of the Scoping Report to EPA, the ESIA team will undertake the following tasks.

- The Project description will be updated and finalised as further engineering and technological details become available.
- Baseline data collection and specialist studies will be completed and reported in the environmental and social baseline chapter. Further stakeholder engagement will also be done.
- Impact assessment will be undertaken to determine significance ratings according to a predefined impact assessment methodology
- Mitigation and monitoring measures will be developed and an outline Environmental Management Plan (EMP) will be prepared as part of the ESIA
- The findings of the ESIA will be reported in a comprehensive ESIA Report for EPA's review and public scrutiny. A Final ESIA Report will be submitted addressing EPA's and public comments.

### 10.3. Proposed Baseline Studies

The baseline studies will be completed employing three main techniques: Desktop Research, Baseline surveys including Specialist studies and Stakeholder Engagement.

During the desktop research, relevant information on environmental and socio-economic aspects of the project will be collated and reviewed. Baseline surveys and stakeholder engagements will be undertaken to provide additional information on the current environmental and socio-economic baseline against which the identified potential impacts will be assessed. Also specialist studies will be undertaken to assess key issues identified during the ESIA Scoping study.

#### 10.3.1 Environmental and Socio-economic Baseline Studies

Primary data will be collected by various environmental and socio-economic specialists to augment the existing data. See *section 10.4 Chapter 5 Baseline Information* for the various data to be collected.

Following completion of the baseline studies, the ESIA team will report the findings in the

ESIA Report. This will provide sufficient information to undertake the following tasks.

- Identify the key environmental and socio-economic conditions in areas potentially affected by the Project and highlight those that may be vulnerable to aspects of the Project;
- Describe their characteristics (nature, condition, quality, extent, etc) now and in the future in the absence of the Project; and
- Provide sufficient data to inform judgments about the importance, value and sensitivity/ vulnerability of resources and receptors to allow the prediction and evaluation of potential impacts.

Specialist studies will be done with the aim to better understanding the extent of impacts as well as recommend mitigation measures. These include;

- Emissions and Air Dispersion Modeling
- Noise Data Analysis and Modeling
- Seawater Modeling (Thermal Plume)
- Greenhouse Gas Emission/Climate Change Study

The ESIA team will determine the impact assessment and mitigation measures based on the results of data collected as well as the specialist studies. The overview of scope of baseline studies is provided in Annex 1 and 2.

#### **10.4. Stakeholder Engagement**

Further stakeholder engagement will be done once the scoping report is submitted to the EPA for review. This begins with the disclosure of the scoping report to the public. After the review, the EPA will issue a letter to inform VRA/SEC to proceed to the ESIA phase. The letter will also include comments on the Scoping Report and proposed Terms of Reference for the ESIA. The Scoping Report will be disclosed by EPA and or by VRA/SEC to other stakeholders subsequent to the EPA’s approval. An advertisement announcing the release of the Scoping Report for comment will be published in a popular newspaper. Copies of the Scoping Report will likely be placed at the following locations (subject to EPA advice) for public review:

- EPA Office, Accra and Cape Coast;
- Esaakyir District Assembly offices, Central Region; and
- Chief at Ekumfi Aboano

During the socio-economic baseline studies, local level engagement activities will be undertaken. This will involve focus group meetings with representatives of the affected community and consultation with the district leadership. These interactions will involve focus group discussions with women’s groups, the youth, traditional leadership, farmer and fisher groups. The aim of these consultations will be to gather data for the socio-economic baseline and identify potential impacts. Stakeholder views and concerns will be gathered during these engagements.

Another level of stakeholder engagement will be the disclosure of the Draft ESIA Report. After the submission of the draft ESIA report to the EPA, copies of the report will be made available at a number of locations for public review and comment. Given the nature of the proposed project it is expected that Public Hearings will be organised by the EPA and attended by VRA/SEC and members of the ESIA team as required. The comments received on the ESIA Report from EPA which will include feedback from the public hearing(s) will be addressed and a Final ESIA Report will be submitted to EPA.

### **10.5. Proposed Structure of the ESIA Report**

The proposed contents follow previous EPA guidance on ESIA Reporting. The content may be altered slightly during the evolution of the Project or based on the findings of on-going consultation, however it is anticipated that the contents of the ESIA Report will align broadly within the suggested framework. The proposed outline is as follows;

#### **Non-Technical Executive Summary**

##### **Chapter 1: Introduction**

This section will provide the general background information relation to the project, and the issues to be covered are:

- a. The purpose and objectives of the proposed project.
- b. Scope and terms of reference of the Environmental Assessment Study.

All relevant information will be drawn from project documents.

##### **Chapter 2: Policy, Legal & Administrative Framework**

This section will provide a combination of relevant policies, plans, legislative and administrative framework, international protocols and conventions and best practices applicable to the project.

##### **Chapter 3: Description of the Undertaking**

A reasonably detailed description of the project will be given here. Issues to be discussed will include:

- a. Description of the project location
- b. A description of the nature, scale and scope of the undertaking.
- c. Definition of the land area to be taken by the development (a site map showing the location of the project area will be provided)
- d. A description of the allocation of different activities/uses to which the proposed land would be put.
- e. Detail description of the project components and stages such as:
  - Pre-constructional, involving land surveys, consultations with stakeholders, land acquisition issues, surveys and acquisition of relevant permits, etc.
  - Constructional / Demobilisation Activities
  - Occupancy activities,

- f. Manpower / Materials requirements for the various stages of the project and their sources
- g. Project Schedule & Financial Requirements
- h. Any other relevant information

#### **Chapter 4: Consideration of Alternatives**

The EIA shall provide all alternative and subsequent designs/options/sites that have been considered, including cost benefit analysis, to date. Issues to be considered shall include alternatives to the undertaking including alternative situations where the undertaking is not proceeded with; matters on site selection including a statement of the reasons for the choice of the proposed site and the other alternative site(s) considered; an identification of existing environmental conditions including social, economic and other aspects of major environmental concern.

#### **Chapter 5: Baseline Information**

This Section shall provide a detailed description of the proposed site including the immediate adjoining land uses and zoning status. A detail study and description of the existing environment (physical, biological and socio-cultural/economy) of the project sites shall be provided.

These shall include, but not limited, to the following:

- a. Physical Environment
  - i. Climate (Wind Speed, Rainfall, humidity and temperature)
  - ii. Air quality
  - iii. Noise
  - iv. Topography
  - v. Geology and geomorphology
  - vi. Seismicity & Geo hazards
  - vii. Hydrology & Drainage (Surface / Ground water)
  - viii. Soils (Site Contamination/ Hazardous Materials)
  - ix. Traffic Assessment
- b. Biological Environment
- c. Terrestrial Receiving Environment
  - i. Wildlife
  - ii. Marine Receiving Environment
- d. Data Analysis & Modelling
  - 1. Emission & Air Dispersion Modelling
  - 2. Noise Data Analysis & Modelling
  - 3. Thermal Plume Modelling
  - 4. Green House Gas Emissions and Climate Change

- e. Socio-Cultural / Economic Environment
  - i. Population and Demographics
  - ii. Ethnic, Religious and Cultural Heritage
  - iii. Historical resources
  - iv. Aesthetics and Tourism
  - v. Infrastructure
  - vi. Education
  - vii. Land tenure and Land Ownership
  - viii. Land Use
  - ix. Employment/Manufacturing
  - x. Agriculture
  - xi. Public Health (including HIV/AIDS)

Relevant pictures, maps, tables, graphs, diagrams and any other illustrative material will be provided that would make easy appreciation of the content of the EIA.

### **Chapter 6: Consultations**

This section will present the findings of all the consultation held in connection with the proposed project with state agencies, District Assemblies and local communities and individuals to be affected by the project, etc, including that by the Project Developers. The discussions will cover the various issues of concern raised and how they have been addressed in the EIA.

### **Chapter 7: Identification, Analysis and Evaluation of Impacts**

This Section shall provide a description of the potential impacts of the proposed the development including the methodology used for the impacts identification. Checklist and matrices methodology will be used. Information on potential, positive and negative impacts of the proposed undertaking from the environmental, social, economic and cultural aspect in relation to the different phases of the development of the undertaking will be provided. Impacts will be described in terms of their nature, duration, magnitude, areal extent and frequency and categorized into all the phases of the project.

The potential impacts of the project will be considered for the pre-constructional, Constructional and Operational/Occupancy Phases. In particular, impacts on or due to the following will be identified and discussed.

- a. Potential impact on Global Climate Change & Greenhouse Gas Emissions
- b. Potential Impact on Socio-economic and local communities
- c. Potential impact on Land Acquisition
- d. Potential Impact on Historical Resources & Cultural Heritage
- e. Potential Impact on Geology and soils
- f. Potential Impact on Noise and Vibration
- g. Potential Impact on Air Quality

- h. Potential Impacts on Traffic and transport
- i. Potential Impact of Waste Releases (fly ash, effluent, solid waste, etc)
- j. Potential Impact of Water Resources
- k. Potential Impact on Seascape, Landscape & Visual intrusion
- l. Potential Impact on Terrestrial Ecology
- m. Potential Impact on Marine Ecology
- n. Potential Impact on Irreversible and irretrievable commitment of resources
- o. Cumulative Impact

Public Safety, Occupational health and safety risks as well as other risks and hazards such as vandalism and theft are also to be identified. To complete this analysis of environmental consequences associated with impacts on public health and safety, the Consortium shall also consider potential impacts on the following issue areas: hazardous materials/hazardous waste, waste management, traffic and transportation safety, worker safety and fire protection, and geologic hazards.

### **Chapter 8: Mitigation Measures**

Mitigation measures for the potential environmental effects that would occur from pre-construction, construction and operational/occupancy activities shall be proposed. Specific mitigative measures against the significant impacts that will have been identified in the previous section will be outlined here. Measures would be defined in practical terms such as costs, manpower, equipment and technology needs.

### **Chapter 9: Monitoring Plan**

These are measures to be periodically carried out to find out significant deviations from baseline conditions. The environmental monitoring programme is a vital process in the Management Plan for any construction projects. This helps in signaling the potential problems that would result from the proposed project and will allow for prompt implementation of effective corrective measures. The environmental monitoring will be required during construction and operational phases.

### **Chapter 10: Environmental Management Plan**

A provisional Environmental Management Plan (EMP) will be developed as part of the provisional EIA. The purpose of the Environmental Management Plan (EMP) is to minimize the potential environmental impacts due to proposed project. The EMP shall reflect the commitment of the Client to safeguard the environment as well as the surrounding population. The potential impacts on the environment from the project are identified based on the nature of the various activities associated with the location, and operation of the proposed project and also on the current status of the environmental quality at the proposed area.

The EMP to be developed shall include the following:

- a. Composition and job description of project environmental and social management unit of the Project Management Team (PMT).

- b. Structure of reporting for project environmental and social management unit and this should be linked with operational and administrative activities,
- c. Parameters to be monitored, these are measures to be periodically carried out to find out significant deviations from baseline conditions.
- d. Monitoring programme in tabular form outlining sampling site, frequency of measurement and costs.
- e. Scheduling & Reporting, including proper and adequate record keeping,
- f. Human and Financial resources for environmental management and monitoring
- g. Environmental audit and review programme covering all activities to assess compliance with contract requirements and ensure meeting requirements of the EPA and other stakeholders including the general public. The programme should include both internal review, undertaken by project developers reporting internally and external audit, undertaken by independent consultants reporting to the Client.
- h. Occupational Safety and Health Management Plan
- i. Emergency Preparedness Plan

### **Chapter 11: Decommissioning**

The goal of project decommissioning and both interim and final reclamation is to remove the installed facilities and equipment and return the site to a condition as close to a pre-construction state as feasible. The procedures described for decommissioning and reclamation are designed to ensure public health and safety, environmental protection, and compliance with applicable regulations. This Section shall outline the procedures for reclamation to include a description of the proposed activities for reclamation to be undertaken during and after completion of project operation and measures to be taken to prevent unnecessary or undue degradation.

### **Chapter 12: Conclusions & Recommendations**

General overview of all conclusions arrived at during the study and recommendations made in order to justify the issuance of an Environmental permit.

### **Chapter 13: References**

List of references used shall be outlined.

### **Appendices**

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## ANNEXES

- Annex 1: Overview of Scope of Biophysical Baseline Studies
- Annex 2: Overview of Scope of Social Baseline Studies
- Annex 3: Sites Technical Evaluation and Comparison
- Annex 4: Comprehensive List of Stakeholders Consulted with to date
- Annex 5: Background Information Document (BID) Used for Scoping Consultation
- Annex 6: Consultation Records
- Annex 7: Scoping Notice

**Annex 1 Overview of Scope of Biophysical Baseline Studies**

Resource	Potential Area of Influence	Approach	Parameters
<b>Ecological Survey &amp; Habitat Assessment</b>			
Terrestrial Soils and Geology	Soils in the immediate area of the proposed site	<p>A geologist/sediment scientist will undertake study of:</p> <ul style="list-style-type: none"> <li>• soil physico-chemical characteristics;</li> <li>• regional geology;</li> <li>• existing soil contamination;</li> </ul> <p>Investigation will include observations, test pits (for soil profiling), and laboratory analysis of surface soil samples on and around the Project site. Sample locations will be selected to represent the various soil types identified.</p>	<p>For field and laboratory testing of soil samples:</p> <ul style="list-style-type: none"> <li>• grain size</li> <li>• total organic matter</li> <li>• hydrocarbons</li> <li>• heavy metals</li> <li>• soil microbiology</li> </ul>
Surface water	Surface water bodies within the zone of influence	<p>A specialists will carry out a study to:</p> <ul style="list-style-type: none"> <li>• determine surface water conditions;</li> <li>• determine quality of surface</li> <li>• physico-chemical properties of the water</li> </ul> <p>Investigation will include observations as well as laboratory and field analysis of samples from three (3) surface water source if available.</p>	<p>For field and laboratory testing of surface water samples:</p> <ul style="list-style-type: none"> <li>• pH</li> <li>• salinity</li> <li>• biological oxygen demand</li> <li>• chemical oxygen demand</li> <li>• turbidity</li> <li>• dissolved and suspended solids</li> <li>• hydrocarbons</li> <li>• heavy metals</li> <li>• microbiology</li> </ul>

Resource	Potential Area of Influence	Approach	Parameters
Hydrogeology	Groundwater within the zone of hydrological influence, both shallow and deep	A water specialists will carry out a study to: <ul style="list-style-type: none"> <li>determine quality of groundwater.</li> <li>determine condition of water</li> </ul>	For field and laboratory testing of groundwater samples: <ul style="list-style-type: none"> <li>pH</li> <li>salinity</li> <li>biological oxygen demand</li> <li>chemical oxygen demand</li> <li>turbidity</li> <li>dissolved and suspended solids</li> <li>hydrocarbons</li> <li>heavy metals</li> <li>microbiology</li> </ul>
Terrestrial Flora	Flora species within the footprint of the Project as well as in the connected bioregion	The specialist will conduct a survey of the terrestrial environment to: <ul style="list-style-type: none"> <li>describe the existing vegetation and habitat types</li> <li>ecosystem delimitation</li> </ul>	Based on desktop study and field survey: <ul style="list-style-type: none"> <li>habitat types</li> <li>plant types and distribution</li> <li>sensitive habitats</li> </ul>
Terrestrial Fauna	Fauna species within the footprint of the Project as well as in the connected bioregion	The specialist will conduct a survey of the terrestrial environment to: <ul style="list-style-type: none"> <li>identify wildlife including birds of conservational importance</li> </ul>	Based on desktop study and field survey: <ul style="list-style-type: none"> <li>animal types and distribution</li> <li>threatened or endangered species or conservational importance</li> </ul>
Intertidal/Subtidal Ecology	Marine species and habitat that occur near Project	An ecologist will conduct a survey of the intertidal and nearshore environment to: <ul style="list-style-type: none"> <li>describe the existing habitats ( rocky or sandy intertidal)</li> <li>identify and determine the density of plant and animals (macroalgae, barnacles, ghost crabs, benthos etc)</li> </ul>	Based on desktop study and field survey: <ul style="list-style-type: none"> <li>habitats</li> <li>marine vegetation types and distribution</li> <li>type and abundance on intertidal organisms.</li> <li>sensitive habitats</li> </ul>

Resource	Potential Area of Influence	Approach	Parameters
			<ul style="list-style-type: none"> <li>threatened or endangered species</li> </ul>
Marine Quality	Water Near shore environment	A specialist will describe the physico-chemical characteristics of the marine water at the proposed Project site.	<p>For field and laboratory testing of marine samples:</p> <ul style="list-style-type: none"> <li>pH</li> <li>salinity</li> <li>temperature</li> <li>total dissolved solids</li> <li>dissolved oxygen</li> <li>conductivity</li> <li>nutrients</li> <li>chlorophyll</li> <li>trace metals</li> <li>hydrocarbon</li> </ul>
Marine Quality	Sediment Near shore environment	A specialist will describe the physico-chemical characteristics of the marine sediment at the proposed Project site	<p>For field and laboratory testing of soil samples:</p> <ul style="list-style-type: none"> <li>grain size</li> <li>total organic carbon</li> <li>TPH</li> <li>PAH</li> <li>Heavy metals</li> <li>Oil and Grease</li> </ul>
Fisheries	Within the footprint of the project (coastal). Understanding local and regional fishing activities, species, fishing areas and livelihoods	<p>Specialists will conduct:</p> <ul style="list-style-type: none"> <li>plankton assessment</li> <li>fisheries assessment</li> </ul> <p>The fishing areas, patterns and species will be identified using desktop information and interviews with fishermen in the directly affected communities.</p> <p>Beach seining will be undertaken to assess diversity and</p>	<p>The field assessment will investigate</p> <ul style="list-style-type: none"> <li>types and abundance of benthic organisms</li> <li>type and abundance of both phyto and zooplankton</li> <li>species fished</li> <li>fishing ground seasonal activities</li> </ul>

Resource	Potential Area of Influence	Approach	Parameters
		composition of the nearshore fish stocks.	
Marine Mammals and Reptile (Turtles)	Within the marine environment as well as the intertidal areas	A specialist will undertake a verification survey to identify turtle, turtle nesting site	The field assessment will investigate: <ul style="list-style-type: none"> <li>• types and abundance of sea turtles</li> <li>• types and abundance of marine mammals seen</li> <li>• turtle nesting sites</li> </ul>
<b>Physical Aspect</b>			
Air Quality Assessment	Air quality in the vicinity of the Project	A specialist will conduct a study to determine the status of local air quality using suitable existing monitoring data, or by conducting measurements at sensitive receptors surrounding the site as determined by the specialist. The study will include confirmation of regional wind patterns as well as any localised patterns	Air quality measurements will be taken for the following parameters: <ul style="list-style-type: none"> <li>• Sulphur oxides (SO<sub>x</sub>)</li> <li>• Nitrogen oxides (NO<sub>x</sub>)</li> <li>• Carbon Monoxide(CO)</li> <li>• Particulate matter (PM<sub>10</sub> &amp; PM<sub>2.5</sub>)</li> <li>• Total Suspended Particles (TSP)</li> <li>• Petroleum Hydrocarbons (PHCs)</li> </ul>
Noise Assessment	Noise levels at sensitive receptors	The study will identify locations of sensitive receptors. Short term noise measurements will be taken during the day and night at sensitive receptors surrounding the site as determined by the specialist. The study will identify locations of sensitive receptors.	<ul style="list-style-type: none"> <li>• Acoustic measurements using a Type I or Type II integrating sound level meter monitoring the slow response, A-weighted, equivalent sound pressure level (Leq) at selected location.</li> <li>• Daytime and night time measurements will be taken.</li> </ul>
<b>Specialist Studies</b>			
Emissions & Air Dispersion Modeling	Extent of air transport of emissions within specified	The study will to estimate and assess local and global air quality impacts from emissions generated by a proposed project from	The Dispersion modeling will be undertaken for regular combustion pollutants include NO <sub>2</sub> , SO <sub>2</sub> ,

Resource	Potential Area of Influence	Approach	Parameters
	location away from the site	both from coal and modeled in a dispersion model	PM <sub>10</sub> CO and CO <sub>2</sub>
Noise Modelling and Monitoring Program	Extent of impact of noise within the specified location away from the site	A noise dispersion model will be done taking into consideration all the noise sources, terrain, sea noises, and topographic data/information. As well as a monitoring program	Identify principal noise generating sources, baseline noise levels and extent of impact
Sea Water Modeling (Thermal Plume )	Within the initial mixing zones of return heated water with the sea.	A specialist will carry out sea water modeling to predict the geometry and dilution characteristics of the initial mixing zone	<ul style="list-style-type: none"> <li>The study will predict the geometry and dilution characteristics of the initial mixing zone</li> </ul>
Green House Gas Emissions/ Climate Change	Local and global influence of emissions of Greenhouse Gases	A specialist will predict the possible climatic impacts of emissions of greenhouse gases during the construction and operation of the thermal power plant. The assessment will provide an overall greenhouse gases emissions balance, source <b>apportionment</b> and cost-effective mitigative measures.	Emissions of Carbon dioxide and other greenhouse gases

**Annex 2 Overview of Scope of Social Baseline Studies**

Aspect	Approach	Parameters
Demographics, Population, Ethnicity Language, Education	A specialist will conduct a study to determine the demographics of communities within the potential area of influence. The study will include both desktop research and primary data collection through focus group discussions and key informant interviews.  The data will be used to identify vulnerable groups within the potential area of influence.	<ul style="list-style-type: none"> <li>• Population data (size of communities, age, gender etc)</li> <li>• population trends</li> <li>• ethnic groups</li> <li>• religion</li> <li>• language</li> <li>• access to education and attainment levels</li> <li>• Education infrastructure</li> </ul>
Livelihoods and Micro-Economy, Key Livelihoods, and Employment	A specialist will conduct a study to determine livelihoods in the potential area of influence.  The study will include both desktop research and primary data collection through focus group discussions and key informant interviews.	<ul style="list-style-type: none"> <li>• livelihood activities (agriculture, fishing etc)</li> <li>• economic importance of aquatic ecosystems</li> <li>• income distribution</li> <li>• occupation and employment structure including proponent's employment plan unemployment</li> <li>• ecosystem services</li> </ul>
Land Use and Natural Resources	A specialist will use a combination of existing maps, satellite imagery and other spatial data to classify and delineate current land use patterns and identify potential development constraints.  Field work will involve groundtruthing and geo-referencing land use within the Area of Influence within broad categories.	<ul style="list-style-type: none"> <li>• land use patterns</li> <li>• settlement patterns and mapping</li> <li>• land tenure</li> <li>• traditional land title</li> <li>• environmental health and ecosystem services</li> <li>• Community property rights</li> </ul>
Social Infrastructure and Cultural Sites	A specialist will conduct a study to determine status of social infrastructure and cultural sites in the potential area of influence.  The study will include both desktop research and primary data collection through focus group discussions and key informant interviews as well as use of GPS to map cultural sites as required.	<ul style="list-style-type: none"> <li>• social organisations and institutions</li> <li>• economic, cultural, religious and historical sites</li> <li>• recreational facilities</li> <li>• cultural traditions</li> <li>• sense of place</li> </ul>
Traffic	A specialist will describe the condition of project transportation routes including:	<ul style="list-style-type: none"> <li>• Traffic counts</li> <li>• Access routes</li> </ul>

Aspect	Approach	Parameters
	<ul style="list-style-type: none"> <li>• condition of road surface; and</li> <li>• safety (noting signage, markings).</li> </ul> <p>The study will also determine the current usage patterns and volumes at key locations including junctions with a particular focus on peak hours as well as transportation practices and access routes in the potential area of influence.</p>	
Community Health, Safety and Security	<p>A specialist will conduct a study to determine community health, safety and security status in the potential area of influence.</p> <p>The study will include both desktop research and primary data collection through focus group discussions and key informant interviews with health professionals.</p> <p>No invasive diagnostic measurements will be taken (eg no blood testing).</p>	<ul style="list-style-type: none"> <li>• host community health and wellbeing status</li> <li>• health determinants</li> <li>• community health needs and concerns of host communities</li> <li>• health infrastructure</li> <li>• Sanitation</li> </ul>

## Annex 3 Sites Technical Evaluation and Comparison

No.	Item	Article	Candidate Sites				
			Domunli (Site 0)	Akwidaa (Site 1)	Atwereboana (Site 2)	Dutch Komenda (Site 3)	Ekumfi (Site 4)
1	Site Conditions	Location	It is 112km at the west of Takoradi. The site is about 1km away from the seashore to the south, to the east distant Bonyere village 2km, and to the north about 2km there is an asphalt road.	It is 30km at the south-west of Takoradi, 2km at the east of Akwideaa, less than 1.5km away from the village around site.	It is 12km at the south-west of Takoradi, more than 2km away from the village.	It is 38km at the east of Takoradi, 3.5km at the east of Komenda, 22km at the west of cape coast.	It is 78km at the west of Accra, 27km at the west of Winneba, 9km at the south-west of Mumford, 50km at the east of Cape coast. It is more than 0.6km away from village.
		The relation with the City Planning	It is accord with the urban planning.	Turtle beach preservation.	Turtle beach preservation. It is occupied by BOST PETROLEUM.	Public beach resort.	It is accord with the urban planning.
		The land Use	The land, which belongs to VRA, was planned for the construction of a gas firing power plant. It is a primeval forest zone with an area of 1600 acres (equal to 667.7 hectares).	The land can be used extends to the stream to the west, and to the hill to the east, the length is 3km. The width is 2km from the seashore to the north.	The land can be used is 2.4km from western lagoon to east, and 2km from southern seashore to north.	The land can be used is 2.0km from west to east, and 2km from southern seashore to north. It is occupied by one American company.	The land can be used is 2.0km from west to east, and 2km from southern seashore to north. The chief of surrounding tribe supports the project.
		The terrain	The site is located near a lagoon entrance, with large areas of coconut and palm trees around. It lies in sand dune areas, and the terrain is relatively flat without any rocks along	The site lies in hilly areas, the terrain is relatively flat. The site lies in hilly areas, the terrain is relatively flat, and the elevation is 3 ~ 10m.	Many palm trees are planted around the site, the terrain is relatively flat, and the elevation is 8m ~ 15m.	Many palm trees are planted around the site, the terrain is relatively flat, and the elevation is 5m ~ 10m.	The site is an undeveloped land with good vegetation on the surface. The site lies in hilly areas, the elevation is 3m ~ 20m. The rock is appeared.

No.	Item	Article	Candidate Sites						
			Domunli (Site 0)	Akwidaa (Site 1)	Atwereboana (Site 2)	Dutch Komenda (Site 3)	Ekumfi (Site 4)		
			the seashore. The elevation is 5m to 50m.						
		Geological Conditions	Pile foundation can be taken for such main buildings as main power house, turbine room, chimney, large-loaded auxiliary buildings (structures) and so on.	Pile foundation can be taken for such main buildings as main power house, turbine room, chimney, large	loaded auxiliary buildings (structures) and so on.	Pile foundation can be taken for such main buildings as main power house, turbine room, chimney, large	Moderate weathered granite can be taken as natural foundation bearing layers for buildings (structures).		
		Hydrological Conditions	the extreme highest tide level which the Return period is 100 years is 2.6m near the sea area of sites. And the Extreme wave Height which the Return period is 50 years is 3.4m. the plant area may be affected by the flood of small tidal lagoon and the tidewater of Atlantic ocean.	the extreme highest tide level which the Return period is 100 years is 2.6m near the sea area of sites. And the Extreme wave Height which the Return period is 50 years is 3.4m. The site is not affected by the Atlantic Ocean tidewater which the Return period is 100 years, but the site may be affected by the local watershed water catchment from north and east.	the extreme highest tide level which the Return period is 100 years is 2.6m near the sea area of sites. And the Extreme wave Height which the Return period is 50 years is 3.4m. The site is not affected by the Atlantic ocean tidewater which the Return period is 100 years, the plant area may be affected by the local watershed water catchment from north and east, and the flood of small tidal lagoon.	the extreme highest tide level which the Return period is 100 years is 2.6m near the sea area of sites. And the Extreme wave Height which the Return period is 50 years is 3.4m. The site is not affected by the Atlantic ocean tidewater which the Return period is 100 years, but the site may be affected by the local watershed water catchment from the north.	the extreme highest tide level which the Return period is 100 years is 2.6m near the sea area of sites. And the Extreme wave Height which the Return period is 50 years is 3.4m. The site is not affected by the Atlantic ocean tidewater which the Return period is 100 years, but the site may be affected by the local watershed water catchment from the north.		
		Meteorolo-gical conditions	The country doesn't have obviously different four seasons but dry and rainy seasons. The rainy season is from May to October, while the dry season is from November to April of next	The country doesn't have obviously different four seasons but dry and rainy seasons. The rainy season is from May to October, while the dry	The country doesn't have obviously different four seasons but dry and rainy seasons. The rainy season is from May to October, while the dry season is from	The country doesn't have obviously different four seasons but dry and rainy seasons. The rainy season is from May to October, while the dry season is from	The country doesn't have obviously different four seasons but dry and rainy seasons. The rainy season is from May to October, while the dry season is from	The country doesn't have obviously different four seasons but dry and rainy seasons. The rainy season is from May to October, while the dry season is from	

No.	Item	Article	Candidate Sites				
			Domunli (Site 0)	Akwidaa (Site 1)	Atwereboana (Site 2)	Dutch Komenda (Site 3)	Ekumfi (Site 4)
			year. The country's annual average atmospheric temperature is between 26°C and 29°C The dominant wind direction is SW in all seasons through the year.	season is from November to April of next year. The country's annual average atmospheric temperature is between 26°C and 29°C The dominant wind direction is SW in all seasons through the year.	November to April of next year. The country's annual average atmospheric temperature is between 26°C and 29°C The dominant wind direction is SW in all seasons through the year.	next year. The country's annual average atmospheric temperature is between 26°C and 29°C The dominant wind direction is SW in all seasons through the year.	to April of next year. The country's annual average atmospheric temperature is between 26°C and 29°C The dominant wind direction is SW in all seasons through the year.
		Plant Land and Demolishment	Plant land: 29x10 <sup>4</sup> m <sup>2</sup> . There is no demolition inside the boundary of site	Plant land: 29x10 <sup>4</sup> m <sup>2</sup> . There is no demolition inside the boundary of site	Plant land: 29x10 <sup>4</sup> m <sup>2</sup> . There is no demolition inside the boundary of site	Plant land: 29 x10 <sup>4</sup> m <sup>2</sup> . There is no demolition inside the boundary of site	Plant land: 29x10 <sup>4</sup> m <sup>2</sup> . There is no demolition inside the boundary of site
		Earthwork	Excavation: 50x10 <sup>4</sup> m <sup>3</sup> Fill: 60x10 <sup>4</sup> m <sup>3</sup>	Excavation: 30x10 <sup>4</sup> m <sup>3</sup> Fill: 40x10 <sup>4</sup> m <sup>3</sup>	Excavation: 30x10 <sup>4</sup> m <sup>3</sup> Fill: 40x10 <sup>4</sup> m <sup>3</sup>	Excavation: 30x10 <sup>4</sup> m <sup>3</sup> Fill: 40x10 <sup>4</sup> m <sup>3</sup>	Excavation: 250x10 <sup>4</sup> m <sup>3</sup> Fill: 260x10 <sup>4</sup> m <sup>3</sup>
		Living Area	Layout near the plant by the sea	Layout near the plant by the sea	Layout near the plant by the sea	Layout near the plant by the sea	Layout near the plant by the sea
		Extension Conditions	Full	Full	Full	Full	Full
2	Transportation	Highway transportation	Agona-Elubo RD is about 2km at the north of the site.	Takoradi-Agona RD (good road surface, 31km long), regional branch road (clay bound macadam pavement in poor condition, 6km long and 7m wide) and regional branch road (clay bound macadam	Takoradi-Agona RD is about 5km at the north of the site, one rural road about 2km at the east of the site connects Takoradi-Agona RD.	Cape Coast-Sekondi RD is about 5km at the north of the site	Accra-Cape Coast RD. is about 15km at the north of the site, the regional branch road I (clay bound macadam pavement in good condition, 5km long and 8m wide), regional branch road II (bituminous pavement in

No.	Item	Article	Candidate Sites				
			Domunli (Site 0)	Akwidaa (Site 1)	Atwereboana (Site 2)	Dutch Komenda (Site 3)	Ekumfi (Site 4)
				pavement in poor condition, 3km long and 3.5m wide) successively locate around the site			good condition, 10km long), and finally regional branch road III (clay bound macadam pavement in poor condition, 2.5km long and 3m wide) successively locate around the site.
		Access Road	The access roads will connect with Agona-Elubo RD. The length is 2km.	The access road will connect with A regional branch road. The length is 0.2km.	The access roads will connect with the regional branch road. The length is 2km. The rural road will be improved, the length is 5km.	The access road will connect with Cape Coast-Sekondi RD. The length is 2km.	The regional branch road III will be occupied by the plant area. The route must be changed to north of the plant, the length is 2.8km. The access road will connect with the changed road, the length is 0.3km.
3	Fuel Supply	Fuel Transportation	The fuel from South Africa will be transported to the plant coal terminal by sea.	The fuel from South Africa will be transported to the plant coal terminal by sea.	The fuel from South Africa will be transported to the plant coal terminal by sea.	The fuel from South Africa will be transported to the plant coal terminal by sea.	The fuel from South Africa will be transported to the plant coal terminal by sea.
		Coal terminal	Be located at the south of the plant area.	Be located at the south of the plant area.	Be located at the south of the plant area.	Be located at the south of the plant area.	Be located at the south of the plant area.
4	Water Supply	Water Source	Sea water, once through	Sea water, once through	Sea water, once through	Sea water, once through	Sea water, once through

No.	Item	Article	Candidate Sites				
			Domunli (Site 0)	Akwidaa (Site 1)	Atwereboana (Site 2)	Dutch Komenda (Site 3)	Ekumfi (Site 4)
5	Ash handling	Ash yard	The proposed ash disposal area is set east of the power plant, and the distance between them is 200m. The area of ash disposal area is $48.15 \times 10^4 \text{m}^4$ . It can form $205.8 \times 10^4 \text{m}^3$ capacity which will be enough for 5 years storage requirement.	The proposed ash disposal area is set east of the power plant, and the distance between them is 200m. The area of ash disposal area is $48.15 \times 10^4 \text{m}^4$ . It can form $205.8 \times 10^4 \text{m}^3$ capacity which will be enough for 5 years storage requirement.	The proposed ash disposal area is set east of the power plant, and the distance between them is 200m. The area of ash disposal area is $48.15 \times 10^4 \text{m}^4$ . It can form $205.8 \times 10^4 \text{m}^3$ capacity which will be enough for 5 years storage requirement.	The proposed ash disposal area is set east of the power plant, and the distance between them is 200m. The area of ash disposal area is $48.4 \times 10^4 \text{m}^4$ . It can form $207 \times 10^4 \text{m}^3$ capacity which will be enough for 5 years storage requirement.	The proposed ash disposal area is chose at a valley, northwest of the power plant, and the distance between them is 1km. The area of ash disposal area is $63 \times 10^4 \text{m}^2$ . It can form $208 \times 10^4 \text{m}^3$ capacity which will be enough for 5 years storage requirement.
		Ash Conveying	The ash and slurry will be conveyed through road, the transportation distance is 0.3km.	The ash and slurry will be conveyed through road, the transportation distance is 0.3km.	The ash and slurry will be conveyed through road, the transportation distance is 0.3km.	The ash and slurry will be conveyed through road, the transportation distance is 0.3km.	The ash and slurry will be conveyed through road, the transportation distance is 1.2km.
6	Power evacuation	Voltage grade and line length	Two 330kV line will be build to the Aboadze substation at the east of Takordi, the length is 145km.	Two 330kV line will be build to the Aboadze substation at the east of Takordi, the length is 50km.	Two 330kV line will be build to the Aboadze substation at the east of Takordi, the length is 35km.	Two 330kV line will be build to exiting 330kV line at the north of the site, the length is 15km.	Two 330kV line will be build to exiting 330kV line at the north of the site, the length is 15km.
		Outgoing Corridor	Power evacuation is towards east, there is enough space.	Power evacuation is towards east	There is enough space.	Power evacuation is towards east	Power evacuation is towards south, then turns west and turn s north, there is enough space.
7	Environmental Protection	The influence	The discharge can meet the requirements	The discharge can meet the requirements	The discharge can meet the requirements	The discharge can meet the requirements	The discharge can meet the requirements

No.	Item	Article	Candidate Sites				
			Domunli (Site 0)	Akwidaa (Site 1)	Atwereboana (Site 2)	Dutch Komenda (Site 3)	Ekumfi (Site 4)
8	Construction Conditions	Construction area	Layout at the north of the plant, the land area is 15x10 <sup>4</sup> m <sup>2</sup> .	Layout at the north of the plant, the land area is 15x10 <sup>4</sup> m <sup>2</sup> .	Layout at the north of the plant, the land area is 15x10 <sup>4</sup> m <sup>2</sup> .	Layout at the north of the plant, the land area is 15x10 <sup>4</sup> m <sup>2</sup> .	Layout at the east of the plant, the land area is 15x10 <sup>4</sup> m <sup>2</sup> .
		Living area for Constructor	Layout at the west of the freight road, the land area is 4x10 <sup>4</sup> m <sup>2</sup> .	Layout at the west of the plant, the land area is 4x10 <sup>4</sup> m <sup>2</sup> .	Layout at the north of the access road, the land area is 4x10 <sup>4</sup> m <sup>2</sup> .	Layout at the west of the freight road, the land area is 4x10 <sup>4</sup> m <sup>2</sup> .	Layout at the west of the plant, the land area is 4x10 <sup>4</sup> m <sup>2</sup> .
		Heavy equipment transportation	Shipping	Shipping	Shipping	Shipping	Shippingg
9	Comprehensive Evaluation	<p>Advantages:</p> <p>(1) VRA has acquired land of 1600 acres.</p> <p>(2) Access road is short, only 2km.</p> <p>(3) The sea is not occupied.</p> <p>(4) A small of earthworks</p> <p>Disadvantages:</p> <p>(1) The site is remote, peripheral infrastructures and supports condition poor.</p> <p>(2) 330kV transmission line is longer.</p> <p>(3) The foundation adopts piles.</p> <p>(4) Water intake pipes are longer.</p> <p>(5) The coal conveying gallery is longer.</p>	<p>Advantages:</p> <p>(1) The sea is not occupied.</p> <p>(2) A small of earthworks</p> <p>(3) The site is relatively flat, and the natural level is proper for the plant layout.</p> <p>(4) Nice water depth.</p> <p>Disadvantages:</p> <p>(1) 330kV transmission line is longer.</p> <p>(2) The foundation adopts piles.</p> <p>(3) Water intake pipes are longer.</p> <p>(4) The access road</p>	<p>Advantages:</p> <p>(1) The sea is not occupied.</p> <p>(2) A small of earthworks</p> <p>(3) The site is relatively flat, and the natural level is proper for the plant layout.</p> <p>Disadvantages:</p> <p>(1) 330kV transmission line is longer.</p> <p>(2) The foundation adopts piles.</p> <p>(3) Water intake pipes are longer.</p> <p>(4) Land acquisition issues, It may be acquired by BOST</p>	<p>Advantages:</p> <p>(1) The sea is not occupied.</p> <p>(2) A small of earthworks</p> <p>(3) 330kV transmission line is longer.</p> <p>(4) The site is flat, and the level is proper for the plant.</p> <p>(5) Access road to be broaden and paved is short, about 4km.</p> <p>Disadvantages:</p> <p>(1) The foundation adopts piles.</p> <p>(2) Water intake pipes are longer.</p> <p>(3) The coal convey gallery is longer.</p>	<p>Advantages:</p> <p>(1) The chief of surrounding tribe support the project.</p> <p>(2) The ground is stable with high bearing strength, no pile foundation expected so far.</p> <p>(3) Access road to be broaden and paved is short, about 4km.</p> <p>(4) Good peripheral infrastructure and supporting condition. Not obvious siltation issues.</p> <p>(5) 330kV transmission line is shorter.</p>	

No.	Item	Article	Candidate Sites				
			Domunli (Site 0)	Akwidaa (Site 1)	Atwereboana (Site 2)	Dutch Komenda (Site 3)	Ekumfi (Site 4)
				condition is bad, 10km access way need to be broaden and paved. (5) The seashore is turtle beach preservation (6) The coal conveying gallery is longer.	PETROLIUM. (5) Environmental Issues, maybe turtle beach preservation. (6) The coal conveying gallery is longer.	(4) Land acquisition issues, the site may be acquired by others.	(6) Water intake pipes are shorter. (7) The coal conveying gallery is shorter. Disadvantages: (1) A large of earthworks (2) The sea will be occupied. (3) The rural will be changed.

**Annex 4 Comprehensive List of Stakeholders Consulted with to date**

<b>Name of Stakeholder</b>	<b>Date of Meeting</b>	<b>Location</b>
GRIDCo	19th January 2015	Tema
Geographic Service Department	30th January 2015	Accra
Meteorological Service Agency	30th January 2015	Accra
Hydrological Service Department	30th January 2015	Accra
Chief and member of EkumfiAboano	25th Januray 2015	Apam
EPA	11th February 2015	Accra
GPHA	16th February 2015	Tema
Ghana Maritime Authority (GMA)	11th February	Accra
Ministry of Power	25th February 2015	Accra
Ghana Maritime Authority	26th February 2015	Accra
Electricity Corporation of Ghana	20th March 2015	Accra
Ghana Investment Promotion Centre	20th March 2015	Accra
Public Utilities & Regulatory Commission	20th March 2015	Accra
Registrar's General Department	20th March 2015	Accra
Town & Country Planning Central Region	31th March 2015	Cape Coast
GPHA	1st April 2015	Tema
Energy Commission	8th April 2015	Accra
Ministry of Power	10th April 2015	Accra
Public Forum	13th April 2015	Accra
GRIDCo	23rd April 2015	Tema
GPHA	13th May 2015	Tema
GMA	26th May 2015	Accra
Office of the President	14th July 2015	Accra
Chinese Embassy	14th July 2015	Accra
Ministry of Power	15th July 2015	Accra
Public Form	15th July 2015	Accra
GRIDCo	30th July 2015	Tema
Chief and people of Ekumfi Aboano	6th August 2015	Ekumfi
GRIDCo	17th August 2015	Tema
Chief of Ekumfi Aboano	26th August 2015	Ekumfi
GRIDCo	18th September 2015	Tema
Ghana Water Comp. Ekumfi Dist	23rd September 2015	Essakyir
ECG Ekumfi District	23rd September 2015	Essakyir
Public Forum	25th September 2015	EkumfiAboano
Chief and people of Ekumfi Aboano	23rd October 2015	EkumfiAboano
EPA	18th November 2015	Accra
EPA	1st December 2015	Accra

## Annex 5 Background Information Document (BID) Used for Scoping Consultation

### Background Information

1. The Shenzhen Energy Group (SEC) in collaboration with Volta River Authority (VRA), intends to develop a supercritical coal-fired generating facility within the coastal region of Ghana.
2. The overall installed capacity of the generating plant is proposed to be 2,000MW in total for the coal-fired power plant project.
3. The project is planned to be developed in two phases; Phase 1 would be 2 × 350MW supercritical generating units construction, and Phase 2 is planned for 2 x 600 MW supercritical generating units construction.
4. Phase I project is planned to be commenced in August 2016 and the 2×350MW units will be completed and put into commercial operation from 2019.
5. The project main components comprises:
  - 5.1 Super-critical coal generation plant
  - 5.2 Coal handling Terminal
  - 5.3 Power transmission line (ROW)
6. It is preliminarily considered to use thermal coal from South African with Net Calorific Value not less than 5,500kcal/kg as the coal source.
7. The coal is shipped from the South African Richards bay and then transport to the affiliated 100,000 DWT coal handling terminal of the power plant. Backup coal source can be available from Columbia or other countries.
8. Environmental standards would comply to EPA guideline for the local requirements of Ghana; flue gas emission shall also meet the relevant IFC and World Bank Group standards.
9. It is proposed to adopt seawater once-through circulation water system for the Project; the circulating water is taken from the basin of coal handling terminal.
10. The fresh water of the power plant is initially supposed to obtain through seawater desalination system; however local sources are being considered.

### Project Activities

#### Construction Phase

Transportation, Drilling, Blasting, Installation and Construction works would account for the vast majority of the activities and consequently the related impact on the atmosphere environment.

### Operational Phase

Operation of the plant including uptake and discharge of sea water, arrival and dispatch of vessels carrying coal and evacuation of electric power.

## Environmental and Social Impact Assessment

Environmental and Social Impact Assessment Report for the development of a 2 X 350MW Coal-fired generating plant and associated facilities would be prepared

The detailed ESIA study to determine the impact of the project on the environment, workers and society and to propose environmental, health and safety impact mitigation measures for the pre-construction, construction/demobilization, operational and decommissioning phases, taken into consideration, review comments from the EPA, other stakeholder agencies and the general public especially the community.

## Stakeholder Comment Sheet

We solicit your response to the following questions to inform of your concerns and appreciation of the project.

1. What are the primary concerns and or benefits the project is likely to cause to you and the community; particularly relating to environmental, economic and social aspects?
2. In your opinion, what are the positive and negative aspects of the proposed project?
3. Do you have or know of any information that might be relevant to the EIA (e.g. environmental information and community, social or economic information).

Annex 6 Consultation Records

PROPOSED COAL-FIRED POWER PLANT BY VRA & SHENZHEN ENERGY GROUP

STAKEHOLDERS FORUM- April 13, 2015

ATTENDANCE LIST

NAME	ORGANIZATION	CONTACT/EMAIL
YAN JIU Sheng	SFC	yanjiusheng@sec.com.cn
NKUGINAMI PRINCE T.	SEC	NKuginami@yahoo.com
Jacob Towson	VRA	jacob.towson@vra.com
Randolph Essandoh	VRA	randolphessandoh@vra.com
Evans A. Owusu	VRA	EVANS-OWUSU@VRA.COM
J. Amoako - BAATH	VRA	jonathan.amoako-baath@vra.com
A. K. AKORUAH	Univ. of Ghana / ESC	akoruah@yahoo.com (0244771707)
Solomon Sarpong	EC	SULUSARPONG@yahoo.com
Moses Duphey	SELJEN CONSULT	moses.duphey@yahoo.com
Michael Anyornmi	SELJEN CONSULT	Kanyornmi@yahoo.com / 0544905098
Ko W. Lam	VRA	Ko W. Lam@vra.com
Nana Asamani Gbedi	REINBEE	0244530630 newmanus@yahoo.com
Edward Anyornmi	VRA	0242956683
Godfred Mensah	ECG	godmensah@ieee.org 0244765788

## PROPOSED COAL-FIRED POWER PLANT BY VRA &amp; SHENZHEN ENERGY GROUP

## STAKEHOLDERS FORUM- April 13, 2015

ATTENDANCE LIST

NAME	ORGANIZATION	CONTACT/EMAIL
Andrew Hancock	GMel-	0277410493
Ben A. Tucker	VRA	0242344779
Kojohn Wang	SEC	0366336906
Loufang Song	FMP1	00862084107438
Yuan-dong	SEC	0544331689
Taijun XU	SEC	0544336918
Sang Xiaodong	SDZPC?	008653185182885
Dehli D. Amogh	Sanon Amogh	0544 336612
Willie Yau	—	024 5131696
Kepi Ellis	VRA	0264334629
Kofi Ostan	VRA	0244234336

## PROPOSED COAL-FIRED POWER PLANT BY VRA &amp; SHENZHEN ENERGY GROUP

## STAKEHOLDERS FORUM- April 13, 2015

ATTENDANCE LIST

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Wang Chunfang	Secpcc	0086/5863163826
Song Yongjun	SEC	Songyongjun@Sec.com.cn
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Joseph Essandoh	Energy Commission	0208187199 jeyeddr@hotmail.com
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Dr. George Dampare		Univ. of Ghana 0246-213315
Anthony Beati	ESL Consulting	0208769258/tonybeati@gsat.com
Kofi Gater	Seljen Consult	0208434557
Nicolas Anyornu	Seljen Consult	0544250088
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Komle Ofun	GDHA	kofun@ghanaports.net 0244366587

## PROPOSED COAL-FIRED POWER PLANT BY VRA &amp; SHENZHEN ENERGY GROUP

## STAKEHOLDERS FORUM- April 13, 2015

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Xi Wenyang	SDEPC	008615020010216
Wang Lei	SDEPCI	008685182705
Zhang lei	SDEPCZ	008613134139299
Hu Yi Gouy	SDEPCI	008653185182389
Bai Ma Jin	SDEPCZ	008653185182625
Li Chengxi	SDEPCI	008618653161519
Lin Yu	SBC	0023244343608

## PROPOSED COAL-FIRED POWER PLANT BY VRA &amp; SHENZHEN ENERGY GROUP

## STAKEHOLDERS FORUM- April 13, 2015

ATTENDANCE LIST

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Zhou Ye	CCCC-FHDI	czhou@yeah.net
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Chengyuan	CCCC-FHDI	chengy@fhdiqz.com
Peter Osei-Agyei	VRA	Peter.osei-agyei@vra.com
Martin Agye	VRA	martin.agye@vra.com
Stephen Ofori	VRA	stephen.ofori@vra.com
Andriana Nelson	EPA	andriana.nelson@epa.gov

# GHANA MARITIME AUTHORITY

In case of reply, the number and the date of this letter should be quoted

GMA 10/3/01/083

My Ref. No.....

Your Ref. No.....



Ministries Post Office  
P. M. B. 34, Ministries  
Accra  
28<sup>TH</sup> AUGUST 2015

*Edlin 1/9/15*  
**THE DIRECTOR  
PLANNING AND BUSINESS DEVELOPMENT  
VRA. P.O. BOX MB 77  
ACCRA**



Dear Sir,

**RE: COAL - FIRED POWER PLANT PROJECT**

We write with respect to the subject matter mentioned above.

Following the VRA / Shenzhen Energy Group and GMA meeting held on May 26, 2015 and the stakeholders' forum on the Pre-feasibility Study Report (PFSR) of the project on July 15, 2015, we submit below relevant comments from the Ghana Maritime Authority.

**Minutes of VRA/SEC and GMA - May 26, 2015**

**3.2**

*To be captured as follows:*

GMA explained that they regulate, monitor and coordinate activities in the maritime industry.

GMA superintends over the Ghana Shipping Act, 2003 (Act 645) as amended and the Ghana Maritime Security Act, 2004 (Act 675) as amended and associated Legislations.

GMA therefore ensures the safety and security of Ports, vessels and other installations including subsea structures within Ghana's maritime jurisdiction.

With respect to the proposed port, GMA will have to ensure that it complies with the provision of the International Ship and Port facility Security (ISPS) Code as specified in the Ghana Maritime Security Act. Therefore a detailed Plan of the proposed port has to be submitted to GMA for the Authority to carry out a port facility security assessment which shall be reviewed and approved by the National Maritime Security Committee. A Port Facility Security Plan shall subsequently be developed and approved for implementation by the port operator.

#### 4.0

*To be captured as follows:*

GPHA is the body mandated to build and operate ports in Ghana. Once GPHA gives the consent for the port to be built, then the port layout and coordinates of the breakwater shall be made available to GMA so that it can be inserted on the appropriate nautical charts, safe navigational routes as well as aids to navigation will also be indicated. (Also 8.3.3 of the PPPFSR)

#### Other issues

During construction and operations: (Also 8.3.3 of the PPPFSR)

Statutory documents of vessels to be engaged in the dredging and construction and other operational works to be submitted to GMA for vetting permission. (Also 8.3.3.1.1 (6) of the PPPFSR)

Any subsea structures such as pipelines intended to be buried on the sea bed must be made known to GMA for clearance before installation.

Statutory certificates / documents of vessels intending to call at the port shall be submitted by the agent of the vessel to GMA. The vessels once in port will also be subjected to Port State Control inspections by GMA staff.

#### For the Power Project Prefeasibility Study Report (PPPFSR)

##### 4.3.2 Meteorology of the Power Project Prefeasibility Study Report

###### *Comment*

The GMA Vessel Traffic Management Information System (VTMIS) is installed with meteorology sensors and the Control Centre equipment in Accra, Takoradi and Tema display the following indicators:

- a) Wind speed and direction
- b) Humidity
- c) Atmospheric Pressure
- d) Temperature

The above indicators are displayed for eight (8) coastal towns viz:

- Keta
- Ada
- Tema
- Winneba
- Cape Coast
- Takoradi
- Axim
- Half Assini

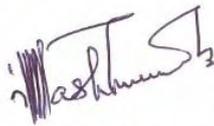
Data from the VTMS Sites could be used to determine the climatic conditions of the five (5) candidate sites of the project.

We do apologise for the late submission but we hope that you will find the above remarks useful in your study.

Please do not hesitate to contact us should you require any further clarification or information.

Thank you.

Yours faithfully,



**CAPT. INUSAH A. NASIR**  
**DEP. DIRECTOR (Environ. & Safety)**  
**For: DIRECTOR GENERAL**

## Annex 7 Scoping Notice



## SCOPING NOTICE



The Shenzhen Energy Group Co., Ltd. of China (SEC) in collaboration with the Volta River Authority (VRA) intends to develop a 2x350MW supercritical coal-fired generating units (including affiliated coal handling terminal), at Ekumfi within the coastal areas of the Ekumfi District in the Central Region of Ghana. This project is known as the “**2 x 350MW Supercritical Coal Fired Power Plant**” and represents the first phase of the development which is to be further expanded either by a 4x350MW (or 2x600MW) supercritical coal-fired generating units.

Notice of the proposed “**2 x 350MW Supercritical Coal Fired Power Plant**” is hereby served for public information, as required under the procedures for the conduct of EIA in accordance with Regulation 15(1) of LI. 1652.

Any person(s) who have an interest, concern, or special knowledge relating to potential environmental effects of the proposed undertaking may contact or submit such concerns, etc., to:

The Chief Executive Officer **AND**  
 Volta River Authority  
 P. O. Box MB 77, Accra  
 Tel No: +233-302-664941-9  
 Fax: +233-30-2662610  
 Email: [corpcomm@vra.com](mailto:corpcomm@vra.com)

The Executive Director  
 Environmental Protection Agency  
 P. O. Box M 326, Accra  
 Tel No: +233-302-664697/8  
 Fax No: +233-302-662690  
 Email: [info@epa.gov.gh](mailto:info@epa.gov.gh)

**Or**

The Deputy Manager,  
 Shenzhen Energy Ghana  
 Coal Fired Pre-project Office  
 Private Mail Bag 267,  
 Community 1 Post Office  
 Tema, Ghana  
 Tel: +233 544343449

**Not later than 31<sup>st</sup> January, 2016**