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Environmental and Social Impact Assessment Report

Prepared For

APPL

5 MW Rice Husk Fired Power Plant in Ikwo Rice Mill Cluster, Ebonyi, Nigeria

January, 2012

Prepared By

Renewable COGEN Asia

PREFACE

This report prepared for Abakaliki Power Plant Limited (APPL) is based upon the site observations, site interviews, details given by APPL about the site conditions and the budget allocated by APPL.

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ABBREVIATIONS

°C	:	Degree Celsius
AC	:	Alternating Current
CO_2	:	Carbon Dioxide
DC	:	Direct Current
DM	:	Demineralisation
EPC	:	Engineering, Procurement and Construction
ESP	:	Electro Static Precipitator
GHG	:	Green House Gas
GEF	:	Global Environment Facility
HP	:	High Pressure
Hz	:	Hertz
Kg	:	Kilogram
kJ	:	Kilo Joule
km	:	Kilo meter
kV	:	Kilo Volt
kW	:	Kilo watt
LT	:	Low Tension
MJ	:	Mega Joule
MW	:	Mega Watt
MWh	:	Mega Watt Hour
O & M	:	Operation and Maintenance
tph	:	Tons per Hour
UPS	:	Uninterrupted Power Supply

1. Introduction

1.1 Background of the project

Ebonyi does not have enough power supply to meet the commercial and non-commercial requirements. Even the available power supply is not reliable as it involves frequent power cuts. Less than 50% of the industries/domestic customers are connected to the grid and the electricity supply is limited to 4 to 5 hours per day. The rice husk produced in Ebonyi State was dumped without any usage which resulted in environmental problems.

United Nations Industrial Development Organisation (UNIDO) was invited by Ebonyi State Government to assist them in setting up a rice husk power plant in Ebonyi.

UNIDO engaged international experts from Renewable Cogen Asia to do the fuel supply assessment study, power generation potential assessment study, pre-feasibility study, detailed feasibility studies, etc. International experts conducted thorough studies and decision was made to implement a 5 MW rice husk power plant in Ikwo industrial cluster. Further data collection was initiated by UNIDO to collect all relevant details, licenses and permits in Abuja. UNIDO also organized site visits to 6 rice husk power plant sites in Thailand.

Shareholders for the 5 MW project was finalized and as per Nigerian regulations, two companies were incorporated, one for power generation and another one for distribution.

APPL also engaged the international consultants and Renewable Cogen Asia to do the project technical design, detailed specification of equipment, tender documents, environmental and socio-impact assessment, business plant, etc.

Renewable Cogen Asia has involved in the development and implementation of numerous biomass power plant projects around the world.

UNIDO already made detailed proposal on this project to Global Environmental Facility (GEF) and has obtained a grant of around USD 1.5 Million for the development, construction and operation of this project. This grant will be immediately used by UNIDO to ensure international best practices for the development, construction and sustainable operation of the power plant.

The purpose of the report is to study the environmental and social impact of this project.

1.2. Project Owner and Contact Details

Under Nigerian Electricity Regulatory Commission, 2 separate companies have to be created; one for generation and the other one for electricity distribution. With reference to this, a project company has been established in the name of Abakaliki Power Plant Limited (APPL) and a separate electricity distribution company in the name of Ebonyi Electric Power Company Limited (EEPCL) has been registered.

Necessary contact details are given below:

Abakaliki Power Plant Limited
C/o Ministry of Public Utilities,
New secretariat Complex,
Nnorom Street,
Abakaliki
Ebonyi, Nigeria
Telephone: +234 43306154
Mobile: +234 8037791357
E-mail: ebonyiunido@yahoo.com
Alternate E-mail: censirt@yahoo.com

2. Project Description

2.1. Power plant site

The power plant is located within the Ebonyi Industrial Cluster at Ikwo. Ikwo cluster is around 60 km away from Ebonyi state administrative capital. As a part of Ebonyi State Government initiative, a cluster is being developed in Ikwo, Ebonyi. Already a private investor is operating a rice mill in Ikwo. The state government is also constructing a rice mill in the cluster.

The following map shows the location of the Ikwo in Ebonyi:

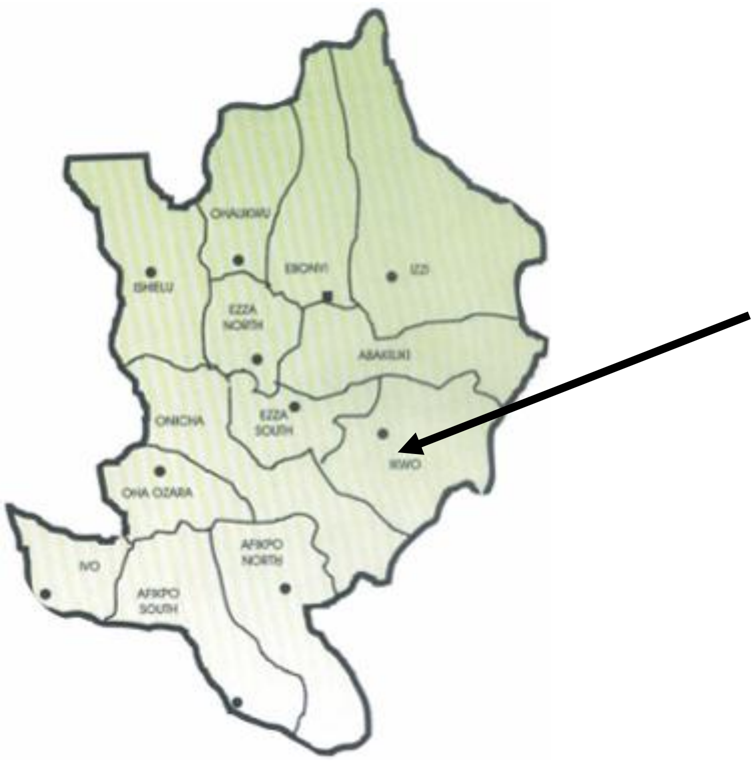

Figure 1: Location map of Ikwo in Ebonyi state

Detailed location map of the project site is given below:

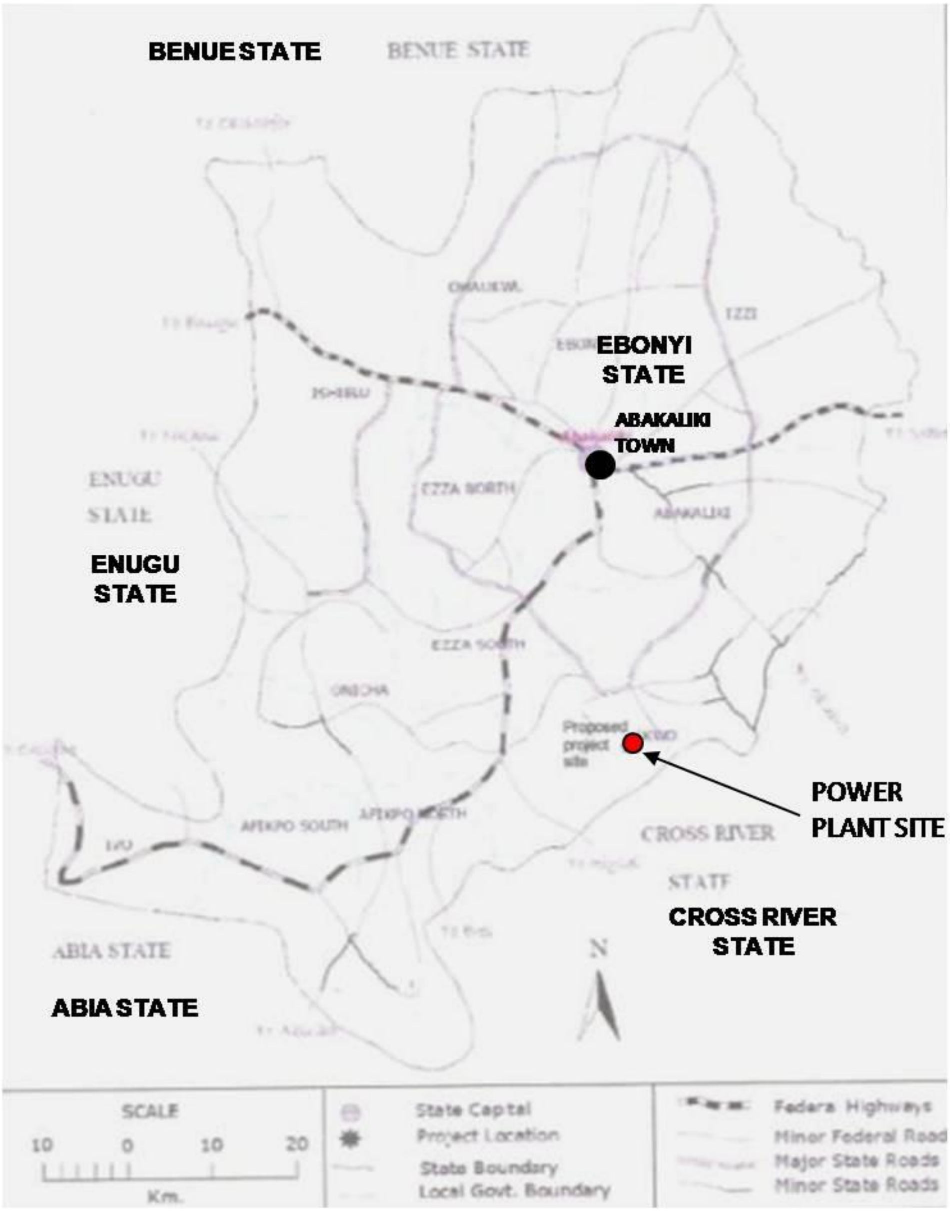

Figure 2: Detailed location map of the project site

The power plant will be located centrally in the cluster such that it is closer to the rice mills. This would ensure reduced transmission losses and investment cost on transmission lines and easy transportation of rice husk.

Figure 3: Details on industrial cluster at Ikwo, Ebonyi

The following photographs clearly depict the rice mills which are operating in the cluster.

Figure 4: 12 tph rice mill in Ikwo cluster

Figure 5: Details of the 5 tph rice mill developed by Ebonyi state government

Figure 6: 5 tph rice mill developed by Ebonyi state government

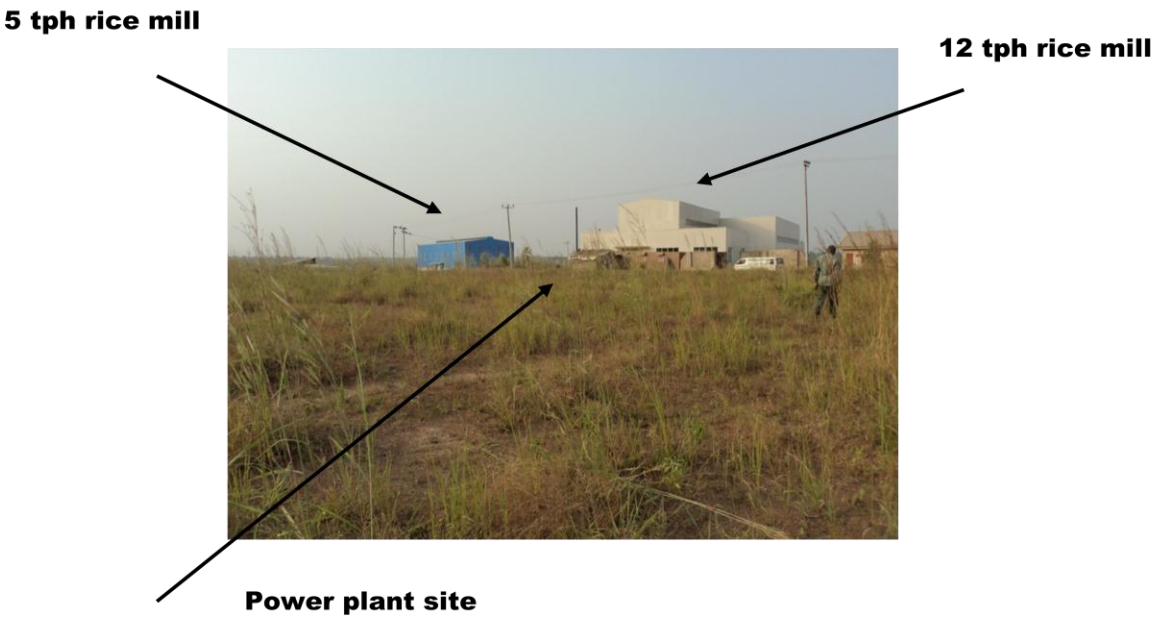

Figure 7: Location of 12 tph, 5 tph rice mills and power plant in the cluster

2.2. Site meteorological condition

The detailed site meteorological conditions such as annual rainfall data, wind speed, wind direction, ambient temperature, evaporation, relative humidity, dew point temperature are given in Appendix 1.

2.3. Power plant design concept

The biomass power plant will be based on the regenerative Rankine cycle. The project is designed to generate a gross power of 5 MW. The power cycle design is optimized for maximizing power generation and power export. For 5 MW size, generally HP heater will not be used.

The boiler will combust only rice husk as fuel and will be designed to ensure reliable steam generation which will be then passed to the steam turbine.

Bleed cum condensing steam turbine generator and auxiliaries are envisaged. The steam turbine converts the thermal energy available in the steam into mechanical energy (shaft power) and the generator converts the mechanical energy into electrical energy.

The exhaust steam from the turbine will be condensed by using cooling tower and is recycled by pumping it back to the boiler. Feed water will be deaerated in a pressurized deaerator.

All the auxiliaries will operate on the generated power. Power generated after meeting the auxiliary load will be exported to the industries in the Ikwo cluster. Diesel generator set will be provided for black start purpose. All other power sources including DC power, UPS, control power, lighting, etc. will be derived from the panels.

The flue gas from the boiler will be passed through the electrostatic precipitator with two fields in order to remove large particles before being sent through the stack. The project will be envisaged to control outlet emission to less than 100 mg/Nm^3. All ash will be mechanically handled and conveyed to an ash silo from which it will be transported for disposal by trucks.

The entire plant will be controlled by a centralized DCS system with inputs and controls of all loops, analysers, control valves, motorized valves, motors, etc.

The power plant will include a complete fire fighting scheme meeting all the international and local standards and recommendations which ensures plant and personal safety during the operation and construction of the power plant. The power plant will have fire detection systems installed at all critical areas. Fire fighting shall include fire hydrant system, CO_2 extinguishers and other powder type extinguishers installed at different places of the power plant.

Raw water will be used as a cooling medium in the heat exchanger equipment of the turbo generator components such as oil coolers, generator air coolers etc.

Required amount of water will be drawn and used as make-up water for boiler, demineralisation, dust suppression system in fuel storage area, dust conditioning, dry ash handling system, etc. A small quantity of water will be required for drinking and sanitation purpose for plant personnel.

Raw water will be supplied to the water pond which will also have a separate partition for fire fighting storage.

Raw water will be treated in the water treatment system. The impurities are sedimented in a clarifier and screened by mechanical filter. The water is then treated in a feed water treatment plant. Certain chemicals are added to improve the quality of water before being fed into the boiler.

Waste water from all locations will be collected in a neutralisation pit. The waste water in the neutralisation pit will be treated with chemicals for pH neutralization. The neutralized waste water will be given sufficient aeration before being let out.

The power plant will be designed for the most economic operation throughout its lifetime and all equipments will be provided with adequate design margins and standby capacity. The power plant will satisfy the following technical criteria:

Fuel	Rice husk
Type of the Plant	Condensing power plant
Number of boilers	1 unit
Number of steam turbine generator	1 unit
Gross electrical output	5 MW_e
Estimated annual operating hours	Minimum of 7,900 hours
Operating mode	Base load electrical matching
Operational lifetime	Minimum of 200,000 hours

2.4. Plant energy balance

For the given project conditions, the steam cycle is 47 bar, 445 °C. The basic system configuration and tentative energy balance of the plant is given in the following figure:

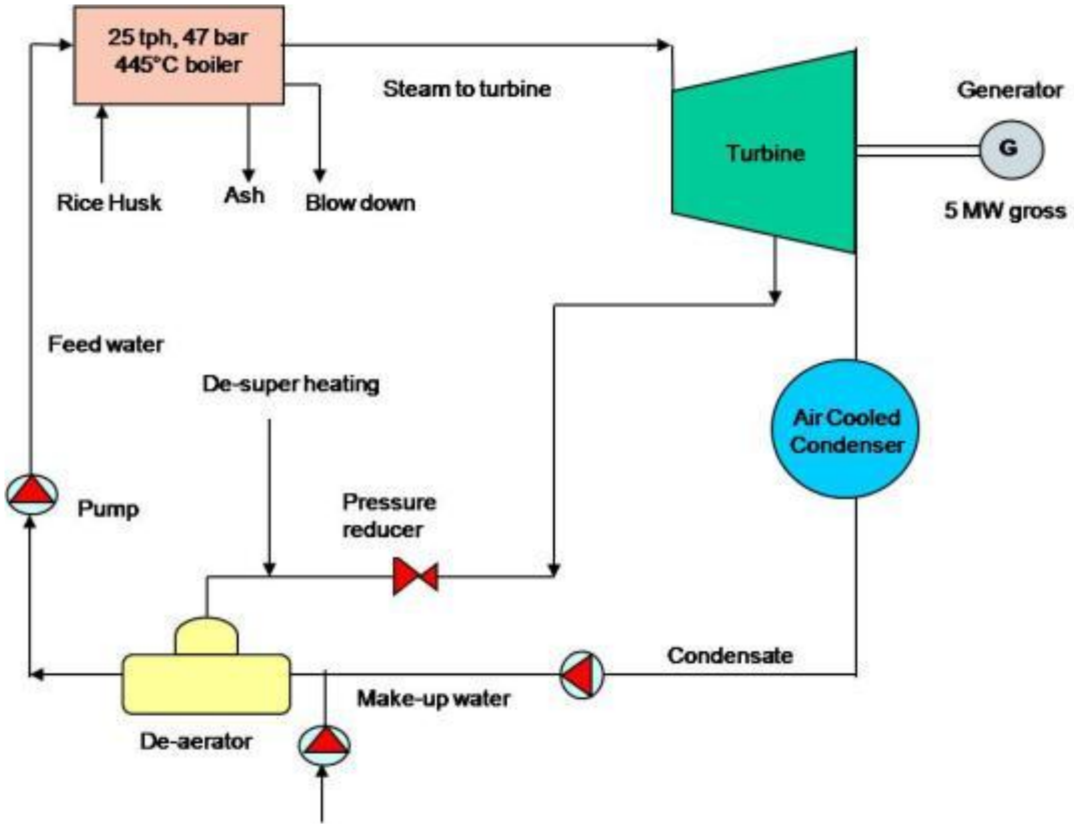

Figure 8: Plant energy balance

2.5. Power generation process

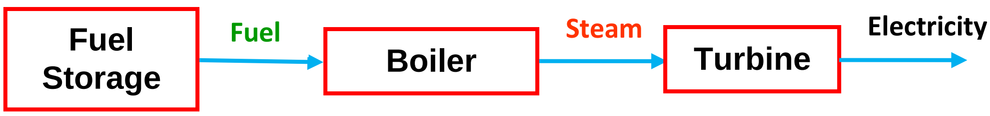

Figure 9: Power generation process

The rice husk power plant mainly consists of following sub-systems:

- Fuel handling and storage system
- Boiler system
- Steam turbine system

<u>Fuel handling and storage system</u>

The design of fuel handling system will be based on the estimated quantities of annual fuel requirements. Rice husk from the storage yard will be made available at the inlet to the feeding system through conveyors. The excess rice husk in the conveyor will be returned to the storage yard through the return rice husk conveyor. The rice husk feeding system in addition to the storage silos will consist of inlet chutes, feeders, feed chutes and the distributor. Flow diagram of a typical fuel handling system is shown in the following figure:

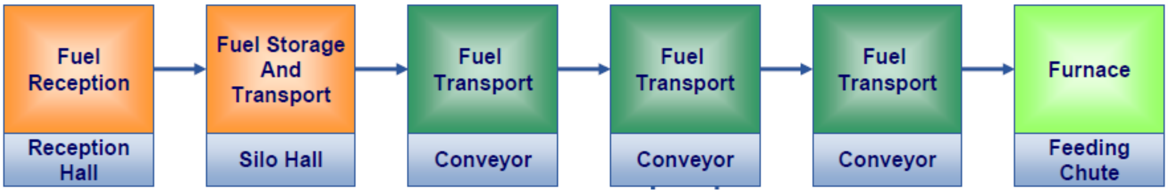

Figure 10: Flow diagram of a typical fuel handling system

A typical front end loaders used for fuel handling is shown below:

Figure 11: Typical front-end loader for fuel handling

Figure 12: Typical open yard storage of rice husk

Figure 13: Typical covered shed

<u>Boiler system</u>

The boiler is designed to generate steam at 47 bar and 445 ± 5 ºC at super heater outlet considering feed water temperature at economiser inlet as 105 ºC. The steam pressure and temperature at the inlet to the turbine will be 44 bar and 440 ± 5 ºC.

Steam generator design is for continuous operation throughout the year with normal steam generation of 30 tph. Usually the steam generation will have a margin of 2 to 3% considering the losses in the steam pipes to the turbine.

The boiler will include, but not limited, to the following components:

- High pressure (HP) parts
  - Economizer
  - Steam drum
  - Down-comers
  - Furnace
  - Primary and secondary super-heaters

- Complete system of valves:
  - Safety valves
  - Water and steam shut-off, check and gate valves
  - Level gauges
  - Necessary fittings

- Observation windows, access and inspection manholes and doors.

- Pipes, ducts, hoppers, funnels, headers, silencers and measuring devices.

- Auxiliary systems
  - Fuel burning system
  - Chemical dosing system
  - Sampling system

- Electrical, control and instrumentation equipment.

Air pre-heater and economiser will be used in order to get the final flue gas temperature within 150°C. Adequate number of soot blowers will be provided to the cover the maximum surface area of the bank. In places where soot blowers are difficult to place, retractable soot blowers will be placed. The boiler will be equipped with a complete blow-down system with the maximum capacity of 5 % of the feed water flow at Maximum Capacity Rating (MCR).

Steam turbine system

The steam turbine generator will consist of the following components:

- Condensing turbine
- Generator and exciter
- Main steam stop and control valves
- Hydraulic fluid system
- Electrohydraulic speed and load control system
- Gland seal system
- Lubricating oil system
- Turbine generator control system
- Protective devices
- Generator breaker
- Condenser
- Condensate pumps

A bleed cum condensing turbine will be used and it will be designed as per the international standard with all necessary systems and equipments. The specific steam consumption of the turbine will be the lowest for operating loads between 80 to 100%.

The generator will include one horizontal shaft 3-Phase AC, synchronous generator of 6.6.kV, 50 Hz at site condition of 50°C ambient. The generator will have brushless exciter with automatic voltage regulators.

2.6. Products

The product of the plant is electricity. The net electricity output is around 4 MW and will be sold to rice mills and other industries in the Ikwo cluster.

2.7. Electricity off-take

The net electricity available for sales is around 4 MW (3,970 kW).

2.7.1. Electricity supply during day time

The electricity supply to the industries of Ikwo cluster during the day time is given in the following table:

Table 1: Electricity off-take

S. No.	Electricity off-taker	Demand (kW)
1.	Ebonyi Agro rice mill	2,000
2.	Rice mill developed by State Government	800
3.	Other small rice mills	1,000
4.	Nearby community and commercial establishments	170
	Total Demand	3,970

2.7.2. Electricity supply during the night time

Electricity supply during the night time will be in the following priority basis:

- Ebonyi Agro rice mill
- Rice mill developed by State Government
- Other small rice mills
- Nearby community and commercial establishments
- Other industries

If the electricity load of the day time priority consumers is reduced in the night time, the excess available electricity will be supplied to other industries in the cluster (total demand of other industries is well in excess of 3 MW).

2.8. Raw material for the power plant

The raw materials used for the power plant during operation are:

- Rice husk (fuel)
- Water
- Chemicals

<u>Rice husk</u>

Rice husk is the main raw material used as fuel for electricity production. The power plant will have 10 days of covered storage and 45 days of open storage. When the rice husk trucks reach the power site, depending upon the requirements, it will be unloaded inside the covered shed or if the covered shed is already full, then the biomass will be unloaded and kept in the open storage. In order to prevent moisture penetration, rice husk in open storage yard will be covered with thick locally available polythene sheets. Rice husk will be used from the storage facilities on first in-first out basis.

Water

The sources of raw water for the power plant during operation phase are by underground water. In addition, there is a nearby river from which water can also be extracted. The raw water will also be treated before use in the power plant.

Water treatment chemicals

Water treatment chemicals used in the power plant need to be stored for 3 months in a warehouse with proper fire protection and ventilation system. Water treatment chemicals will be stored, handled and processed in covered areas to minimize contamination. These chemicals will be stored in a chemical storage tanks.

2.9. Raw material and equipment transportation

Since the power plant will be located in a cluster where the rice mills are going to be established, rice husk will be available at a shorter distance. Hence, the transportation of rice husk will be carried out for a shorter distance only around 1 km. The water is available in the site itself. Other mode of transportation is not required for water.

Construction materials and main equipment such as boiler, turbine, will be delivered to the site by trucks.

Water treatment chemicals required for the operation of the power plant facility will be transported by trucks or containers to the power plant and stored in a warehouse with proper fire protection and ventilation. Water treatment chemicals will be stored, handled and processed in covered area to minimize contamination of storm water with chemicals.

2.10. Fuel availability and usage

Annual rice husk generation

The following table gives the annual rice husk generation in Ikwo cluster:

Table 2: Annual rice husk generation

S. No.	Rice mill	Annual paddy processing (tons)	Annual rice husk generation (tons/year)
1.	Ebonyi Agro	120,000	30,000
2.	State Government	37,500	9,375
3.	Small rice mills	75,000	18,750
	Total	**232,500**	**58,125**

Rice husk required for power generation

The size of the power plant is 5 MW. The fuel requirement for the power plant is 1.2 ton/MWh. Hence, the rice husk required for the power plant is around 45,030 tons/year.

Rice husk would be fed pneumatically with manual over ride and complete with necessary air piping, valves, fittings, etc. The fuel storage capacity of the fuel bunker will be for 3 hours. The system will also include a covered Rice husk storage yard to stack maximum days' storage of Rice husk as per the area earmarked for the same.

The capacity of under-roof and outdoor storage area is for 5 days operation and 45 days operation at MCR, respectively. Rice husk will be used from the open storage facility in a first in-first out basis.

2.11. Plant layout

Surveyor diagram on the power plant site is given in Figure 14 and the detailed diagram of the power plant site is given in Figure 15. The power plant layout is given in Figure 16.

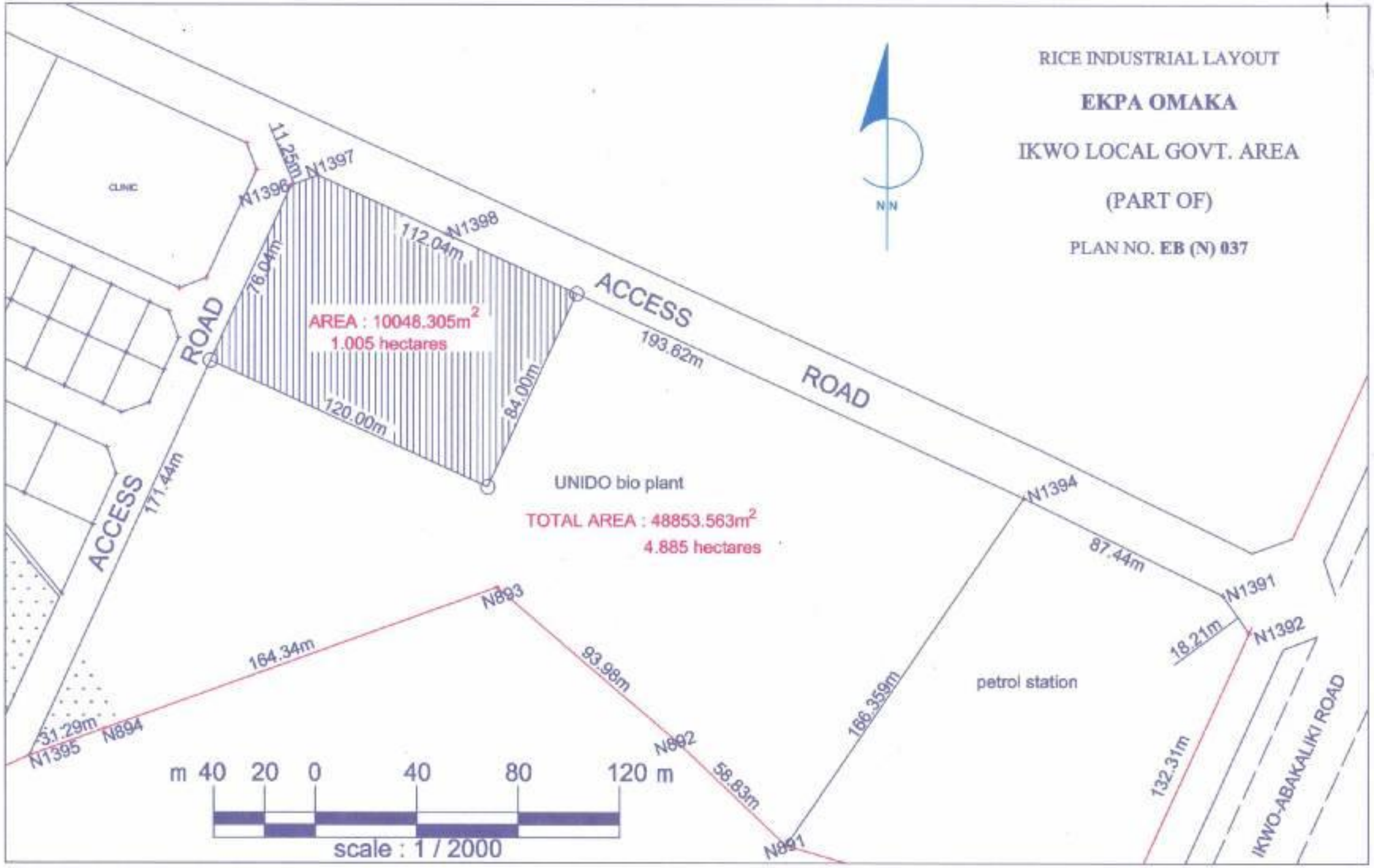

Figure 14: Surveyor diagram for the power plant site

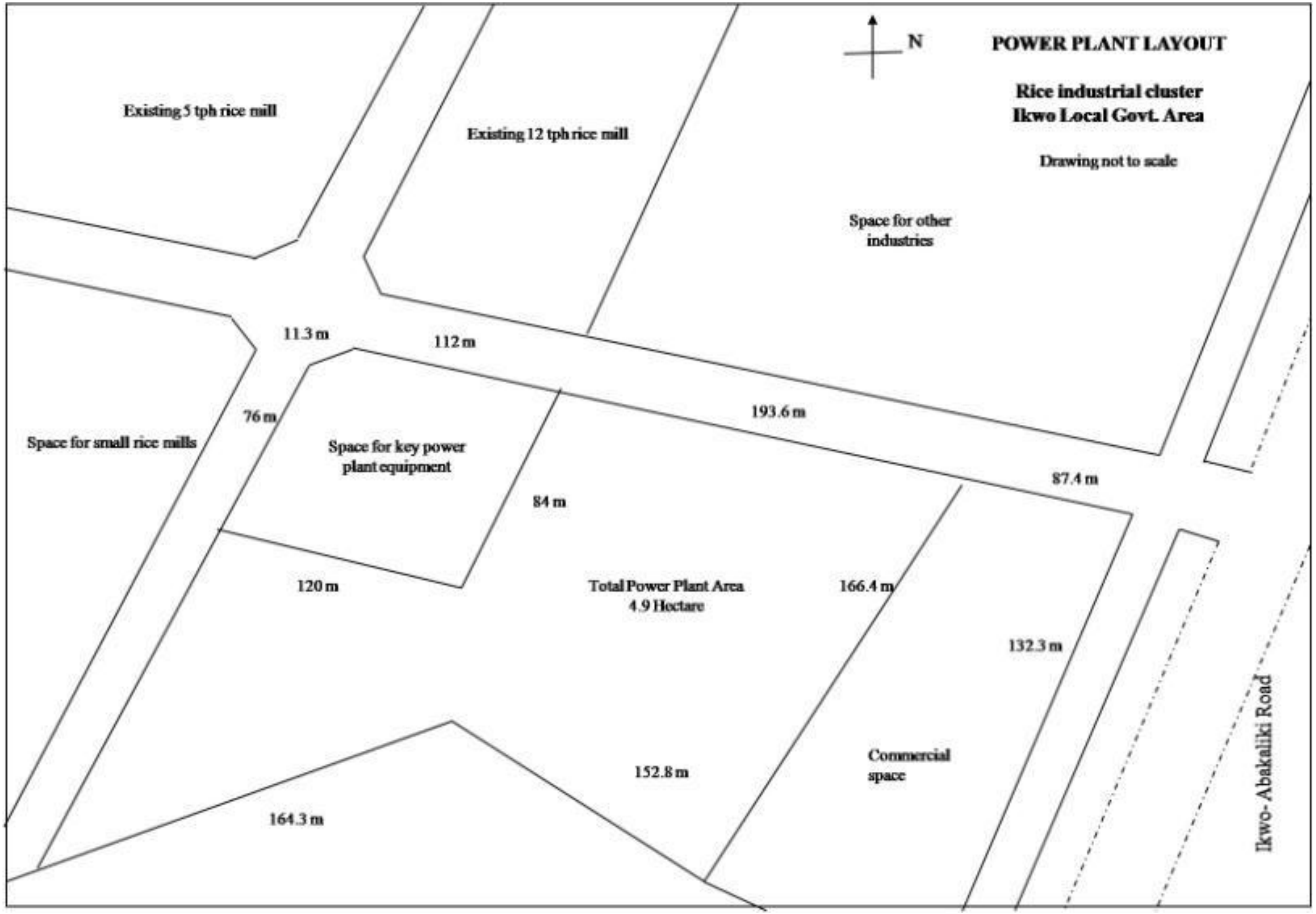

Figure 15: Detailed diagram of the power plant site

Figure 16: Power plant layout

2.12. Annual plant operating hours and lifetime

The power plant will be in operation for a period of at least 8,000 hours/year. The operational lifetime of the power plant depends upon the annual operating hours and its maintenance. For a well-maintained plant with state-of-the-art equipment operating for around 8,000 hours per year the lifetime of the biomass power plant shall be from 25 to 30 years. With a major maintenance program, it is possible to extend the lifetime by another 5 years.

2.13. Requirement of water

In order to use less amount of water for power plant the power plant is using air cooled condenser instead of water cooled condenser. Water requirement is given in the following table:

Table 3: Water requirement

S. No.	System	Normal make-up water (m^3/hr)
1.	Cooling system evaporation loss and blow down	1
2.	De-mineralized make-up water for boiler make-up	1.5
3.	Sludge, back wash, regeneration equipment of DM plant/filtration/RO reject	1.5
4.	Drinking, sanitation and miscellaneous use	1
	Total	5

The hourly water requirement is only around 5 m^3/hr

2.14. Operation and management

The proposed O & M structure is given in figure below. A special purpose company, APPL, has been set up for the development, implementation and operation of the proposed 5 MW rice husk power plant. An Electricity distribution company has been set up to deal with electricity distribution to individual rice mills and collection of energy payments. A contract will be signed with the EPC contractor with applicable construction guarantees.

Manpower required for the power plant

There will be two major groups of personnel needed for the efficient running of the power plant: the Operation and Maintenance staff (O&M) and the Administrative staff.

The power plant will be operated in a 3 shifts/day basis. For 3 shift operation, 3 sets of key operational teams plus 1 set for rotational staffs are required to operate the plant on daily basis (3 x 8 hours).

The Plant manager and the administrative staff will work only during the day shift i.e., from 8.00 a.m. to 5.00 p.m. The following table shows the power plant operation and maintenance staff:

Table 4: Power plant operation and maintenance staff

S. No.	Position	No. of persons
1.	Plant manager	1
2.	Shift-incharge	4
3.	Boiler attenders	4
4.	Turbine operators	4
5.	DCS operators	4
6.	Fuel & ash handling operators	8
7.	Maintenance manager	1
8.	Mechanical personnel	
	• supervisor	1
	• technician	1
	• workshop technician	4
9.	Electrical personnel	
	• supervisor	1
	• technician	1
10.	Welder specialist	1
11.	Workshop in charge	4
12.	Store in charge	1
13.	Plant chemist	1
14.	Logistics, safety and pollution control in-charge	1
	Total	**42**

The actual number of power plant Operation and Maintenance staff may vary according to the design philosophy of the selected EPC contractor. The following table shows the power plant Administrative staff:

Table 5: Power plant administrative staff

S.No.	Position	Unit
1.	Administrative manager	1
2.	Accountant	1
3.	Clerk/Office secretary	1
4.	Driver	2
5.	Cleaners	2
	Total	**7**

The final manpower figure will be known only after the selection of EPC contractor and finalisation of the exact O&M plan.

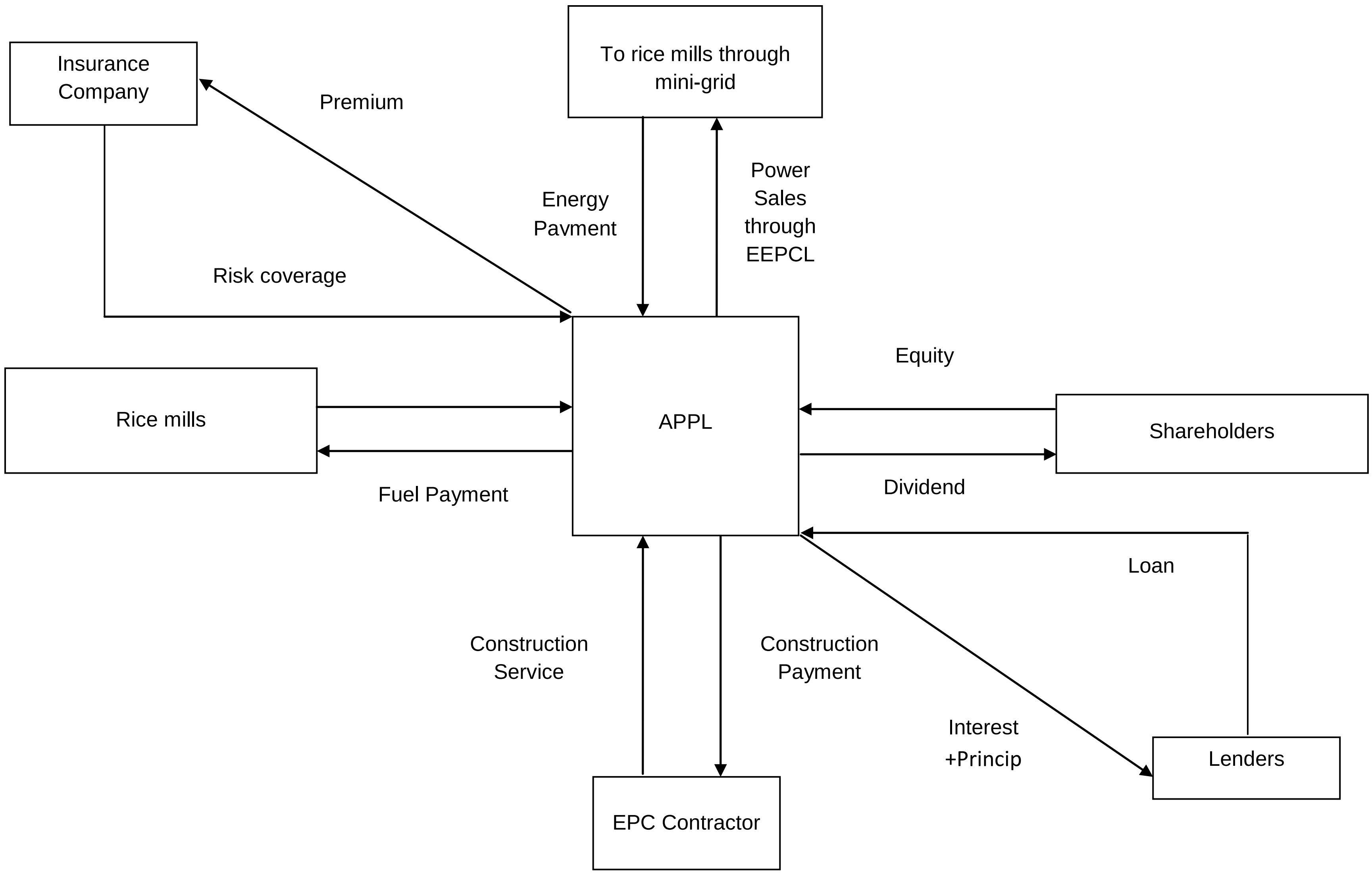

Figure 17: Proposed operation and management structure

3. Existing environmental conditions

Information on the existing conditions is obtained by field study conducted at the site by the consultant. The existing environmental conditions are described below:

3.1. Natural and physical environment

Geographical location

The power plant will be located in the Ikwo cluster which is around 60 km away from Ebonyi state administrative capital.

Topography and land features

Total land area available for the project is around 5 hectares out of which power plant will be built in an area of 1 to 1.5 hectare. The project site has a flat topography with the boundaries sloping outwards in two sides.

Figure 18: Soil structure at the site

Climate

The tropical climate of the Ebonyi state is broadly of two seasons which are the rainy season between April and October and dry season between November and March. Temperature throughout the year ranges between 21 °C to 29 °C and humidity is relatively high. The annual rainfall varies from 2,000 mm in the southern areas to 1,150mm in the northern areas. The state enjoys luxuriant vegetation with high forest zone (rain forest) in the south and sub-savannah forest in the northern fringe.

More details are given in Appendix 1.

Wind direction

The dominant wind direction during harmattan period (November - February) in Enugu (nearest meteorological station to the project site) is mainly northeasterly, with values ranging 10 - 20Kts (5 - 10m/s), with peaks of about 23 - 25Kts (12m/s). During the rainy season, i.e. March - October, the dominant direction is from the southwest.

The speed ranges 5 - 15Kts, and when accompanied by squalls, the maximum gusts reach 60 - 80 Knots (30 - 40m/s). On the diurnal basis, i.e. daily variation, the nights are fairly variable or calm during the rainy season, and the day is from the southwesterly direction. During harmattan however, both night and day experience similar wind regime, that is, northeasterly winds in moderate speeds.

More details are given in Appendix 1.

Natural drainage features

There are no other permanent natural water courses nearby to the site. The site boundaries are sloping in nature which provides the natural drainage features.

Figure 19: Natural slope available at the boundary of the site

Air quality

The site and surrounding area is rural, consequently air quality is considered to be good.

Water quality

There is a small canal at a distance of 500 m from the power plant site. There will be very limited waste water generation in the power plant. The waste water will be treated in an equalization pond before being used for growing trees inside the power plant premises. There will not be any waste water discharge to the nearby river.

Figure 20: Existing canal around 500 m away from site

Noise

This area is typical of rural areas. While the power station is not running the major noise sources for residents are agricultural and earth moving equipment. Other noise sources would be the operation of the rice mills located nearby to the power plant in the cluster. During the operation of the power plant, the noise levels would be limited to less than 70 dB (A).

Visual landscape

The project site offer views of a rural landscape on a mostly flat, or gently undulating, landscape, sloping at the boundaries. There are no sea views at this location. The site is fully visible to residences on the side of the village that is closest to the site.

3.2. Biological environment

Vegetation within the site is predominantly grass (Figure 22). Around 40% of the land is without any vegetation, 55% of the site is covered with grass upto 1 feet height and the rest 5% of the land has grass of 2 to 3 feet height. Other than grass no other significant vegetation was found at the project site. No animal species were found at the project site.

Since the site is located in an industrial cluster it is devoid of any valuable biological or ecological resources such as forest or wild animal. There is also neither aquaculture nor animal farm in and around the project site.

Figure 21: Vegetation (grass) at the site

Figure 22: Indicative height of the vegetation (grass) at the site

3.3. Human use values

Land use

The site is located in an industrial cluster. The power plant site is surrounded by rice mills, land allocated for new rice mills and other commercial activities (currently empty).

The project site is located around 500 m away from Ikwo - Abakaliki road. The site is just to opposite to a 12 tph existing rice mill.
A village is located a distance of 1 km away from the power plant site which houses 15 to 20 houses.

Figure 23: Land opposite to the power plant site

Figure 24: Commercial establishments at a distance of 1 km

Public utilities

12 tph rice mill, opposite to the power plant site, is connected with PHCN grid. The rice mill (5 tph) developed by the Ebonyi State Government will also be connected with PHCN grid. These rice mills will also be connected with public water supply line from the new water treatment plant owned and operated by Ebonyi State Government.

Transportation

The power plant site will be connected well by road facility. The main road being used is Ikwo-Abakaliki road which links the cluster at Ikwo with the state administrative capital at Abakaliki. This road is just 500 m from the power plant site. The existing interior road connects the power plant site with Ikow-Abakaliki road.

Figure 25: Ikwo-Abakaliki road

Figure 26: Road leading to the power plant

3.4. Socio-cultural and community environment

Archaeological sites

No historically/archaeologically important site is in the site or nearby vicinity.

Employment

Most of the people either work as labourers in the rice mills or engage in farming activity.

4. Environmental Conditions after Project Operation

4.1. Natural and physical environment

Land and topography

The land topography will not be disturbed. The natural drainage due to the sloping land will ensure that the power plant area will not be inundated with the water during floods.

The power plant is around 20 to 50 m above mean sea level. Historically there has been no flood occurrence in the chosen power plant site.

Water resources

A water pond will be built within the power plant site. This pond will be used as the main water resource during power plant operation. Under ground water will be source of water. The waste water generated from the power plant will not be discharged to the nearby canal. It will be treated and used for irrigation within the power plant green area.

4.2. Biological environment

The biological resources in the power plant site will not be changed

The main boundaries of the project area will be planted with trees and be maintained as the green belt. This will be used as natural wind shield which protects the distribution of rice husk and the same time used as a sound screen.

4.3. Human use values

Transportation

Since the entire rice husk required will be available from the 12 tph, 5 tph and other small rice mills, the transportation of rice husk from other rice mills to the power plant will be reduced to a considerable extent, resulting in fuel transport within the cluster only. The travel of the plant personnel by cars or motorcycles including the transportation of chemicals by small trucks will not significantly increase the number of vehicles in the road.

Land use pattern

There will be 49 workers in the power plant and most of them will be residents next to the project site. The produced electricity will be sold to the Ebonyi Electric Power Company Limited (EEPL) which will distribute electricity to the rice mill and other industries in the cluster. This will not change any land use pattern.

4.4. Socio-cultural and community environment

Socio economic conditions

There will be significant improvement of the socio-economic condition of the people in the area since the owners of the rice mill will expectedly get more income from rice husk sales along with job opportunities at the power plant. The electricity from the power plant will promote business development in the area and nearby.

Public health

The change in public health will be less because the project is relatively small, few number of workers involved. The occupational health and safety of workers will be taken care. Proper protective devices such as ear plug, mask, helmet, etc will be provided to the workers. The industrial cluster will also house a medical clinic for which the land has already been allocated.

5. Environmental and Social Impacts

5.1. Environmental impact

5.1.1. Pre-construction phase

As such the pre-construction activity itself has no direct impact on the environment (e.g. testing, project design). Within this phase the building plan is prepared and technology supplier and building contractor are chosen. The building contractor will follow conditions set in the building plan and also in permission issued by the relevant public authority.

Impacts

The pre-construction activity has no direct impact on the environment (e.g. studies, project design, etc). In this phase, the EPC contractor is chosen. While selecting the technology supplier, the preference would be given to the one, who is able to supply technology in accordance with Nigeria environmental requirements.

Preventive and mitigation measures

No significant mitigation measures are required during this phase.

When making selection of technology supplier, the preference would be given to that one, who is able to supply technology in accordance with environmental requirements. Also materials for construction and for equipment building should be selected taking into account the abandonment phase as they should not contain restricted components, like ODS (Ozone depleted substances, as freons, CFCS a HCFCS), PCB and polychlorinated terphenyls, asbestos, or other materials given on internationally valid lists. Plastic components, parts, materials and products should not contain flame (fire) retardants, which would contain polybrominated biphenyls (PBBS) or polybrominated biphenyleters (PBDES), polybrominated biphenyloxid (PBBOS) and materials of similar character.

In the pre-construction phase it is also necessary to prepare logistics of fuel transport and handling as well as waste transport (construction material, ash, etc.) to the place of final use or disposal.

5.1.2. Construction phase

Impact on area and vegetation

The initial effect on the land will be that of the changes to be expected on the place, where the power plant along with the rice husk storage facilities will be built, including land clearance, cut and fill, clearing of vegetation located in the proposed construction site.

No important vegetation is located on proposed construction site except for grassland.

Preventive and mitigation measures

Significant effect on the area and topography is expected. But the storage facility will be provided with sufficient arrangements, such that there would not be any dispersion of dusts, washing away of fuels, etc.

In the construction phase, transport routes and construction site shall be arranged to avoid damages. The transport routes should be aligned, marked and maintained.

During power plant construction, power plant site would be covered with new trees/vegetation and this would compensate for the cleared vegetation.

Impact on hydrology

The project site was not found to be prone to flooding. There is no nearby water body. The topographic changes on the site from hydrological causes would be insignificant, and short-term.

Preventive and mitigation measures

No significant waste water generation is expected during the power plant construction.

Impact due to noise and dust emission

Increased noise and dust emissions during the construction phase: Heavy trucks and earthmoving equipment will operate on the site and there will be a consequent production of increased noise and short-term fugitive dusts.

Preventive and mitigation measures

Noise will be either minimized using special low noise equipment (e.g., electrical hammers instead of compressed-air hammers) or its impact will be minimized by moving noisy construction works in day hours. Use of noise suppressors or mufflers will be required for heavy equipment. Power generators and compressors will be provided with enclosures.

Impact due to wastes

During the construction phase and also during machinery and electrical installation, wastes will be generated.

Preventive and mitigation measures

All wastes would be sorted out and managed using standard approaches, either by recycling or by dumping by following relevant standards. Waste management will be the responsibility of the building contractor and technology supplier based on relevant permission.

5.1.3. Operational phase

Impact on air quality

Production of electricity on the site will be sources of emissions of pollutants into the air. In the absence of a boiler technology determination, estimating the emission levels of a proposed power plant relies on data from existing rice husk biomass plants. Nitrogen oxides (NO_X as NO_2), Sulphur dioxide (SO_2), Particulates (PM and PM10) are known to cause negative health and other environmental impacts. Carbon dioxide is a greenhouse gas that contributes to global warming. This gas does not have a direct impact on human and animal health.

Preventive and mitigation measures

In the process of biomass burning, the gas produces will be carbon dioxide, sulphur dioxide and oxides of nitrogen. In this process, it was found that only small amount of SOx and NOx can occur. With the use of Electrostatic precipitator (ESP) with collection efficiency of 99%, the biomass power plant would comply with the Nigeria's environmental regulation especially in case of particulate, CO, NO_2 and SO_2 emissions. Therefore, the concentration of these gases will not have any negative impacts.

Trees will be grown around the plant area to prevent dust dispersion

Impact due to fuel dust dispersion:

The raw material will also disperse and the transfer of particulates from the raw material in storage yard and also while transferring from truck to pile and from pile to machine can give mirror effect because the storage and transfer process will be carried out in open area.

Preventive and mitigation measures

Trees will be grown around the plant area to prevent dust dispersion from the open storage yard and at the same time serve as a wind shield and sound screen.

In addition to that, the workers working in the power plant will use mask to protect themselves from dust and particulates.

Impact due to noise

During its regular operation, the power plant will be a source of noise in the following processes / technologies:

- Fuel and ash transport and handling
- Inlet, generators, turbine, exhaust stacks and ventilation fans
- Steam bypass and boiler or chimney cleaning by steam.

Preventive and mitigation measures

The plant will be designed in such a way that the ambient noise at the perimeter fence will not exceed the local standards.

In case of emergency, an intensive source of noise will be steam blown off. Also regular boiler cleaning by steam would cause extensive noise. In those special cases, local standards levels of noise for regular operation could be exceeded. Boiler cleaning by steam will be done only during daytime to minimise adverse impact of noise to the surrounding people.

Impact on water quality

The water is used for various purposes in the power plant. The sources are raw water, cooling water, blow down water etc. The significant potential impact is discharge if water in the nearby river or stream without treatment.

Preventive and mitigation measures

A wastewater treatment system is proposed along with the power plant. All the wastewater generated in the power plant would be properly treated, including pH treatment and used for plantations inside the project boundary.

In addition the usage of air cooled condensers has been explored which further reduces the impact on hydrology of the power plant site.

Impact due to waste

During the operational phase, wastes of various origin and types will be produced. The most important waste will be the bottom ash and fly ash from fuel burning

Preventive and mitigation measures

Fly ash would be collected in a silo and stored. Bottom ash would be collected using submerged ash method. These wastes would be properly disposed or used for soil conditioning.

The night soil and urine from the toiler that is generated will be collected in a septic tank and treated by a onsite treatment system.

Impact on land use pattern

The project is located in the separate area where there are no households. There is no land accumulation problem, relocation of households etc. Hence the project cannot cause any negative impact on land use.

Preventive and mitigation measures

As discussed earlier, the project cannot cause any negative impacts on land use. Hence, there is no recommendation for mitigation in this aspect.

Impact on aesthetic value

The project will be visible from the areas near to the power plant. The visual impacts of the smoke stacks, fuel storage silos are considered significant.

Preventive and mitigation measures

No preventive and/or mitigation measures are needed as viewers are expected to become accustomed to the new landscape over time.

5.1.4. Abandonment phase

Impact on air quality

When the power plant and the process boiler are abandoned, air quality would improve because of fewer pollutants.

In the event of demolition, particulate matter is expected to increase, but only temporarily.

Preventive and mitigation measures

Similar preventive and mitigation measures like those in construction phase will be implemented here.

Impact on soil

Soil contamination may be possible even long after the project is abandoned. This is a result of lubricating oil leakage and improper disposal of waste during operation.

Preventive and mitigation measures

Possibility of soil contamination will be assessed through a soil-testing program, especially in the vicinity of oil storage areas. If positive for contamination, the area will be subject to remediation or decontamination. Toxic or hazardous materials remaining in the site will be collected along with the contaminated soil for appropriate disposal. An accredited transporter will be contracted to undertake the required treatment and proper disposal.

Impact due to demolition waste

Poor management of wastes can lead to visual and aesthetic problems, as well as health and ecosystem impacts from possible contamination of land and water.

Preventive and mitigation measures

The project commits to emphasizing management of demolition and solid wastes, especially hazardous ones. The project will implement an integrated solid waste management during demolition where the approach of handling wastes will be through waste segregation into recyclables and non-recyclables, reuse or resale of recyclables, and collection and proper disposal of non-recyclables in approved landfill sites.

5.1.5. Summary of environmental impacts

Little natural vegetation will be impacted by the proposed works and it is considered unlikely that the construction of the power station would contribute to degradation of habitat values at the site.

Water availability at the site is limited and hence Air cooled condensers are considered as an option for condenser. There will be no discharge of the water from the power plant. It has been planned to treat the waste water and use it for irrigation purpose.

It is considered that conventional measures for ensuring environmental protection (e.g. fuel storage and handling, erosion and sedimentation control and vegetation management) at a work site will be adequate for the protection of terrestrial habitat values.

5.2. Economic impacts

Construction and operation of the power station has a huge potential to impact on the economic well-being of the local community in the way of providing number of job opportunities.

The project provides a variety of economic opportunities including constant revenue for the rice mills.

5.3. Social impacts

Development of the power station has potential to impact on the well-being of the nearby communities as well as those near the rice mills. Community consultation has to be conducted to identify the concern within the community with regard to traffic safety, noise, air quality and water quality.

The equipment supplier will build capacity and transfer technology to the local workforce by deploying foreign experts to work at the plant after commissioning. Thus the project will improve the technical knowledge, skills and attitudes of the local population.

5.3.1. Impact on technology transfer

Construction of rice husk fired power plant and the biomass boiler is a typical example of technology transfer from one country to the other. It promotes cleaner, more efficient, technically sound and environmentally compatible technology.

The aim of the project is to demonstrate advantages of such technology to business community, mainly on high energy efficiency and the use of local biomass.

The experts will train the plant staff on the operation and maintenance and provide advice on trouble-shooting and other relevant aspects of the plant's operations. The project activity thus involves transfer of technology to Nigeria. The project will motivate many other project developers to adopt such technologies in future in the country.

5.3.2. Impact on community welfare

The 5 MW Rice husk fired power plant construction will have the following impacts on community welfare:

- Consumers will be relieved from frequent power cuts and load shedding
- Will contribute towards meeting the future power demand of the community
- Consumers will immensely benefit from better regulations and power quality.
- Increased use of power will increase the demand for more electrical goods and this will spur the growth in the industrial sector

5.3.3. Impact on security of supply

Since the power plant will use the available rice husk, it will reduce the dependence on diesel for power generation. Also, the rice husk power plant is independent of imported energy sources and world energy market prices. Shift from diesel to rice husk as source of power will leave more diesel for other use (e.g. transportation) where it is more difficult to find alternatives.

5.3.4. Impact on employment

The proposed power plant will require skilled and semi-skilled personnel during construction and operation. The power plant company will have a total of around 49 permanent employees during its operation phase and will be hired or sub-contracted. Many of them will be from the communities surrounding the site.

5.3.5. Impact on migration

There will be no relocation of the people from their habitats. There are 15 to 20 houses at a distance of 1 km from the power plant and they will not be disturbed. Hence there will be no impacts on migration/relocation.

5.3.6. Impact on host government revenue

The plant contributes to the economy of the host government by reducing the dependence on fossil fuel for power generation. Considering the 4 MW of net available electricity, the country could avoid usage of considerable amount of diesel and other fossil fuels. The amount spent by the state on purchase of diesel and natural gas can be utilised for any other alternative productive purpose.

5.3.7. Impact on the country's infrastructure

The project will improve the stability of the electricity supply system. Moreover, the existence of the power plant will result in the expansion of old businesses and establishment of new businesses such as many production factories, restaurants/hotels, etc.

5.3.8. Land acquisition for the project

The power plant including the biomass storage yard requires around 5 hectares of land. The power plant has been allocated with 5 ha already and hence, availability of land for the power plant is not an issue.

Moreover, the project is located far away from residential or commercial area. Hence, there is no relocation of households for the construction of the power plant.

5.3.9. Impact on human use values

<u>Impact during transportation</u>

The traffic will be slow due to the transportation of some big instruments. There will be noise and air pollution from heavy instruments working and from the trucks. However since the site is away from the habitation, there will be little impact on the people.

Impact on water supply

Since there is no water supply system in area in which project site is located, it is expected to have no impact on water supply. However, a water treatment plant will be installed to supply clean water to the plant and be used for consumption by the workers.

5.3.10. Impact due biomass transport

Once the power station is operational, heavy vehicle traffic will be a feature. It has been recommended that construction and operational vehicle movements are limited to daylight hours only.

5.3.11. Land use

No change to land use will be brought about by construction or operation of the site. It is recommended, however, that residents be kept informed of activities at the construction site. This will be particularly important during noisy activities.

6. Environmental Protection Measures

6.1. Emission level

The emission levels from the proposed power plant are given in the following table:

Table 6: Emission levels from the power plant

S. No	Unit	Level
1.	Particulate Emission	< 100 mg/Nm^3
2.	NOx Emission	< 150 ppm
3.	SOx Emission	negligible

All emission levels from the power plant shall be well within the permissible limits.

Ash/particulate control system

Fly ash will be removed from the flue gases by an electrostatic precipitator (ESP). Electrostatic precipitator of 99.9% efficiency will be installed to limit be installed to limit the particulate concentrations below 100 mg/Nm^3. ESP will contain at least 2 fields for stringent pollution control. ESP unit will be complete with casing, hoppers, screen, rapping arrangement, emitting and collecting system, heating elements for hoppers and insulators, transformers, rectifiers and controls.

Figure 27: Typical ESP

Ash generated during the operation of power plant will be suitably collected and disposed off. The ash generated in the boiler will be designed to collect both bottom ash and fly ash i.e., from the furnace bed, banks, economizer and air pre-heater (APH) zones and the electrostatic precipitators.

Submerged belt type conveyor will collect and convey the ash from the boiler bed. Screw conveyor will feed the ash from APH and economizer on to the cross belt conveyor.

Bottom ash handling system is designed for continuous operation for 24 Hours. Submerged belt conveyor will be used for this purpose.

Fly ash handling system is designed for continuous operation for 24 Hours. Dense phase pneumatic system will be used for Fly ash handling along with dedicated fly ash silo

Although, Fabric filter is one of the options for pollution control devices, it is not recommended for this rice husk power plant because of the problem of frequent filter replacement. Also, these fabric filters have a high maintenance cost.

Electrostatic precipitators having a collection efficiency of 99% is the most suitable device.

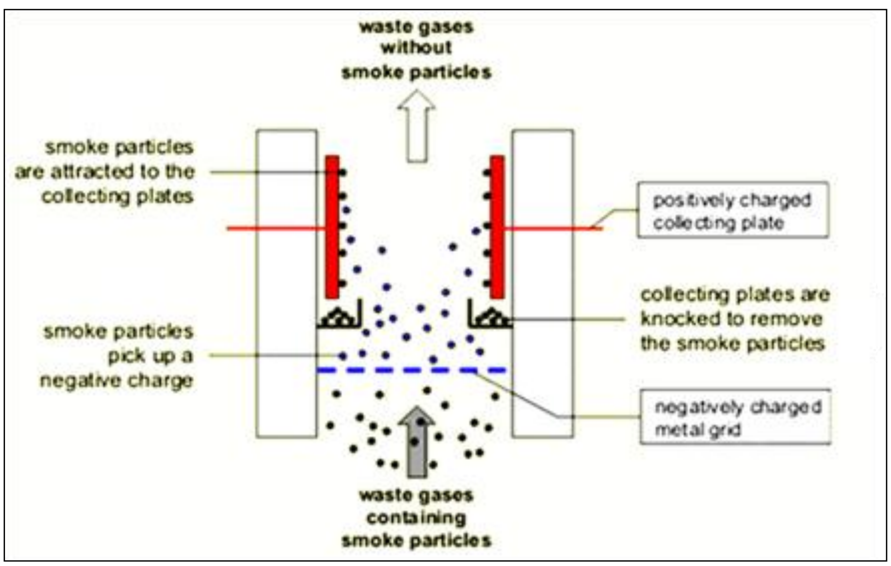

Figure 28: Typical working of an ESP

The flue gas laden with fly ash is sent through pipes having negatively charged plates which give the particles a negative charge. The particles are then routed past positively charged plates or grounded plates, which attract the now negatively charged ash particles. The particles stick to the positive plates until they are collected. The air that leaves the plates is then cleaned from harmful pollutants.

6.2. Noise level

The noise level ranges from various noise generating sources in the proposed power plant is given in the following table:

Table 7: Noise levels from various power plant components

S. No	Unit	Noise level dB(A) 1 m away
1.	Turbine unit	80-85
2.	Cooling tower	65-70
3.	Air compressors	80-85
4.	Transformer	70-75
5.	Boilers	80-85

All these are within the permissible noise level standards.

In addition the following noise management measures will be taken:

- Only equipments which conform to noise levels prescribed by regulatory authorities will be used
- Provision of acoustic enclosures to noise generating equipments like pumps
- Provision of thick green belt to attenuate the noise levels; and
- Provision of ear plugs to the workers working in high noise level area

6.3. Wastewater treatment system

Cooling tower blow-down water, boiler blow-down water, DM regeneration water, filter back wash and sewage water shall be treated in the waste water treatment system. Also, regeneration effluent of the demineralization plant shall be neutralized by the waste water treatment plant together with above.

The wastewater treatment system shall as a minimum comprise of a neutralization tank, a septic tank, sand removal ponds, a sludge pond, an oil separator and a holding pond.

The holding pond is intended to collect wastewater from the Power Plant before releasing it to the outside channel.

Sewage water from office building will be treated in a septic tank before being delivered to a sand removal pond and then to the holding pond.

Oil contaminated wastewater (transformer, turbine and other) will be treated in an oil separator prior to discharge to the outside channel.

The boiler blow down from the flash tank will be routed to the cooling tower return line. Cooling water blow down will be routed to the holding pond.

Wastewater from regeneration process (demineralization Plant), chemical cleaning and drainage will be treated in a neutralization tank to control the pH-value and then pumped to the sand removal pond before release to the holding pond.

Wastewater from backwash and drainage (pre treatment Plant) will also be routed to a sludge pond in order to remove the semi-metals and the clear water is then pumped to the clarifier tank.

Rainwater from the outdoor paved and drained areas must be routed to a sand removal pond before being releasing to the raw water pond.

The power plant will be designed to treat the wastewater from several sources of the power plant and will meet the effluent standards. Sufficient aeration will be provided before being let out.

Figure 29: Typical neutralisation pit

7. Environmental Monitoring Programs

7.1. Monitoring of air pollution

The project will set up a plan for air quality monitoring. This involves monitoring of air samples annually using standard procedures to ensure that the air quality meets the standards.

Sampling	Parameter	Unit
Air quality samples	Particulates	mg/Nm^3
	SO_2	ppm
	NO_x	ppm

7.2. Monitoring of wastewater discharge

The project activity involves closed cycle. Hence, there is no discharge of water outside the boundary. The wastewater generated from the power plant is treated properly and used for plantation inside the project boundary. There is no discharge of wastewater in streams, lakes etc.

However, the treated waste water is discharged outside the project boundary, and then the treated water samples are collected and monitored annually for following parameters:

Sampling	Parameter	Unit
Water quality samples	pH	
	Temperature	^oC
	BOD	mg/l
	DO	mg/l
	Total coliform bacteria	CFU/100 ml

7.3. Monitoring of ash disposal

The ash generated from rice husk will be used for any other useful purpose such as soil conditioning. This will be monitored in order to ensure that the waste can be disposed with appropriate standards.

7.4. Public health monitoring

Annual check-up will be conducted by the community hospital to the workers who are working in the power plant. The monitoring is carried because of their exposure to dust, emissions, noise and heat. For the workers, especially their lung function will be the most addressed parameter.

8. Disaster Management Plan

8.1. Potential hazards

The various hazards associated with the proposed 5 MW rice husk power plant are outlined as below:

Table 8: Potential hazards associated with the biomass power plant

S. No	Blocks/areas	Hazards identified
1.	Rice husk storage in open yard	Fire, spontaneous combustion
2.	Rice husk handling	Fire
3.	Boiler	Steam explosions
4.	Steam turbine generator buildings	Fires in lube oil system, cable galleries, short circuits in control rooms and switch-gears
5.	Switch-yard control room	Fire in cable galleries and switch-gear/control room
6.	Light Density Oil (LDO) Containers Heavy Furnace Oil (HFO) Containers	Fire

The quantity of hazardous substances like LDO, HFO used in the proposed 5 MW rice husk biomass power plant for initial firing of boiler is very less. Hence the major fire and explosion accident due to the use of these materials is very less.

8.2. Hazard reduction strategies

The following opportunities shall be considered by APPL as a potential means of reducing the identified hazards and other hazards:

- Buildings and plant structure designed for cyclones and seismic events
- Provision for adequate water capacity to supply fire protection systems and critical process water
- Security of facility to prevent unauthorized access to plant, introduction of prohibited items and control of onsite traffic
- Development of emergency response management systems commensurate with site specific hazards and risks (fire, explosion, rescue and first aid)

8.3. Fire protection facilities

To protect the working personnel and equipment from any damage or loss and to ensure uninterrupted production adequate safety and as a part of the disaster management plan, the following protection facilities are proposed for the 5 MW power plant:

- Portable Fire Extinguishers: All plant units, office buildings, stores, laboratories; MCCs etc. shall be provided with adequate number of portable fire extinguishers.
- Automatic Fire Detection System: Unattended vulnerable premises like electrical control rooms, cable tunnels, MCC, oil cellars etc. shall be provided with automatic fire detection and alarm systems
- Manual Call point systems: All major units and welfare/administrative building shall be provided with manual call points for summoning the fire fighting crew from the fire station for necessary assistance.

Some of the critical locations where these fire fighting systems will be installed includes the following locations:

- Boiler
- Turbine
- Control Room
- Fuel Yard
- Transformers

Fire fighting system will be adopted as per statutory requirements. Fire fighting system for the proposed power plant will consist of the following:

- Electrically driven fire water pumps
- Engine driven fire water pump
- Water piping with gate valves up to the required location
- Jockey pump to maintain the header pressure

Figure 30: Typical fire fighting system

Figure 31: Typical powder type fire extinguisher

The following important instructions shall be considered in case of any fire accident:

- Overall control of the fire fighting operations shall rest with the senior most officers present at the scene of fire, who will be assisted by the operational and fire staff.
- While turning out for fire calls, the fire department staff shall be guided to the correct location immediately on their arrival
- In-charge of the section at shop floor shall explain risks involved and guide the in-charge of the fire fighting crew.

<u>Fire fighting teams</u>

The fire fighting teams shall consist of the following:

- First line fire fighting team:
  - Operational/maintenance staff and/or plant personnel working in the area
- Second line fire fighting team:
  - Fire station shift-in-charge and trained fire fighting personnel
  - Ambulance driver with ambulance
  - Functional head of affected area
  - Shift In-charge
  - Security personnel

- Third line fire fighting team:
  - Fire officer and auxiliary fire fighting personnel
  - All department heads
  - Local fire brigade from government, if necessary

The small fire shall be tackled by the first line team. Major fire shall be tackled by the line second line and the third line fire fighting teams.

8.4. Occupational health and safety

A safety committee will be set up for implementing safety programs. It will be chaired by the power plant construction manager and will consist of the following members:

- Safety engineer
- Site superintendents
- Field supervisors nominated by the construction manager
- Sub-contractor's site managers and safety managers

Safety engineers will be responsible for operational health and safety, particularly, on inspecting and implementation of the safety programs and for reporting any accidents to the manager to ensure that all the safety, particularly on inspecting and implementation of the safety programs and for reporting any accidents to the manager to ensure that all the safety measures are functioning properly.

Safety orientation will be held for all new employees on the requirements of the safety program. The agenda of the orientation will include:

- Brief explanation of the project
- Safety/security control policy
- Outlines of applicable regulations and requirements for the project
- Emergency procedure
- First aid service

APPL has to properly plan and take steps to ensure appropriate occupational health and safety.

The problem of occupational health in the operation and maintenance phases is primarily due to noise which could affect hearing.

The working personnel shall be given the following appropriate personnel protective equipments.

- Industrial safety helmets
- Zero power plain goggles with cut type filters on both ends
- Zero power goggle with cut type filters on both sides and blue colour glasses

- Welders equipment for eye and face protection
- Cylindrical type earplug
- Ear muffs
- Leather apron
- Boiler suit
- Safety belt/linemen safety belt
- Leather hand gloves
- Acid/alkali proof rubberized hand gloves
- Canvas cum leather hand gloves with leather palm
- Electrically tested electrical resistance hand gloves and
- Industrial safety shoes with steel toe
- Protective clothes and shoes (rubber boots)
- Safety hats

All working personnel shall be medically examined at least once in every year and at the end of his term of employment.

Safety organisation

A qualified and experienced safety officer shall be appointed by APPL or any of the power plant staff can be trained to perform this activity. The responsibilities of the safety officer include identification of the hazardous conditions and unsafe acts of workers and advice on corrective actions, conduct safety audit, organize training programs and provide professional expert advice on various issues related to occupational safety and health. The officer would be responsible to ensure compliance of safety rules/statutory provisions.

Job procedures manual for safety and security will be established, which will be implemented by the following approaches:

- Organize the safety committee to be responsible for implementing the safety programs
- Clean up the work site once per week and store all materials neatly in designated areas
- Posters and signs for accident and fire prevention will be written and conspicuously displayed
- Provide historical data filing and retrieval

8.5. Green area

The boundary of the project site will be planted with trees and be maintained as the “green area”. The trees will be grown around the plant and also around the open fuel storage area. This protects the dispersion of rice husk and at the same time used as a CO_2 absorber and sound screen.

8.6. Contingency plan

A contingency plan shall be prepared by APPL based on the plant general layout, available resources and the analysis of hazards.

It shall be aimed at the pre-emergence activities, emergency time activities and post-emergency activities.

APPL shall consider the following services as a pre-cautionary measure against any potential disaster/hazard:

- Fire fighting service
- Medical service
- Pollution control service
- Public relation service
- Telecommunication service
- Transport service
- Evacuation service
- Security service
- Welfare service

An alarm system shall be provided with a wailing type siren at a centralized place and actuators at the strategic locations in the plant. Adequate number of telephones shall be provided in each unit, so that a person can either directly raise the alarm or ring up disaster control room from where the alarm can be raised directly.

Mock drills shall be conducted for training the persons and to check the performance of men and equipment and also to keep them fit for any emergency.

The plant manager will be the primary emergency response coordinator and has the following responsibilities:

- To notify all regulatory agencies as necessary
- To activate emergency procedures as defined
- To complete initial and final incident reports and submit to appropriate agencies
- To brief incident and accident plan
- To establish communication procedures
- To designate appropriate emergency equipment to utilize

8.7. General emergency procedures

In the event of an emergency including fire, explosion, spill or any unplanned release of hazardous constituents to the air, soil or surface water:

a) The emergency co-ordinator will assist in identifying the character, exact source, amount and extent of any discharged materials
b) Activate internal facility alarms or communication systems to notify all facility personnel
c) Notify appropriate emergency response agencies with designated roles if their help is needed
d) Assess possible hazards to human health or the environment that may result from the discharge, fire or explosion both directly and indirectly. Take steps to minimize the risks to human health or environment
e) Immediately notify appropriate local authorities if an assessment indicates that evacuation of local areas may be advisable
f) Immediately after an emergency, the emergency response coordinator shall provide for treating, storing or disposing of recovered waste, contaminated soil or surface water, or any other materials that results from a discharge, fire or explosion at the facility

The site emergency organization chart is given below. The existing power plant staff can be assigned to take various responsibilities as per the chart given below.

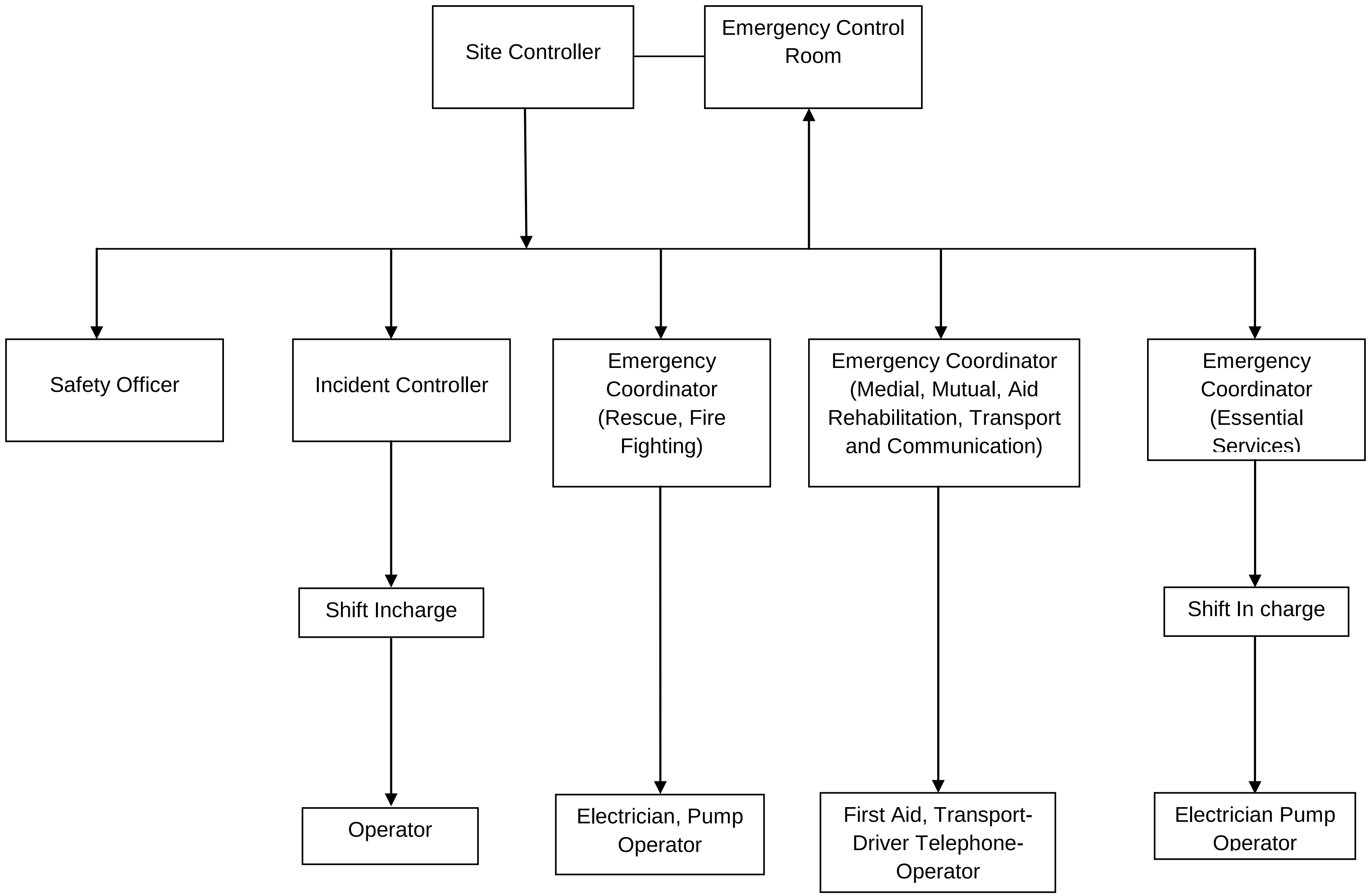

Figure 32: Site emergency organisation chart

9. Global and Local Environmental Benefits

9.1. Global environmental benefits

The use of biomass for power generation is environmentally very advantageous, since it helps in the mitigation of greenhouse gas (GHG) emission resulting from the electricity generation from fossil fuelled power plants.

The project activity is installation of 5 MW rice husk power plant directly results in emission reduction through electricity generation that replaces diesel usage. The direct emission reduction is calculated using fuel savings attributable to the investment. The power generation capacity of the plant is 5 MW. Out of the 5 MW gross capacity with 95% load factor, 12% will be the parasitic load and 5% will be transmission and distribution losses. The net 4 MW will be the power available for sales. The power plant can operate 7900 hours in a year. Hence, the net amount of electricity is 31,371 MWh.

The generated electricity from the 5 MW power is used for diesel replacement (diesel replacement is around 9.5 Million litres). The power plant has a useful lifetime of 20 years. The emission factor for the technology used in baseline scenario is 0.8 t CO_2/MWh.

Amount of electricity generated (A)	: 31,371 MWh
Emission factor for diesel (B)	: 0.8 t CO_2/MWh
Average useful investment lifetime (C)	: 20 years

Direct emission reduction	=	A x B x C
	=	31,371 MWh x 0.8 tCO_2/MWh x 20 years
	=	501,936 t CO_2e

Global environmental benefits from the generated electricity, which replaces diesel usage is 501,936 tCO_2e.

9.2. Local environmental benefits

In the absence of the 5 MW rice husk power plant, the rice mills would have continued to use inefficient diesel drives. The operation of existing diesel drives results in poisonous smokes which has huge impact on the rice mill operators and local public. Also these diesel mill drives creates lot of dust pollution. By replacing the diesel mill drives with the electricity from the 5 MW power plant, these environmental problems are considerably reduced.

10. Conclusion

The environmental and socio-economic impacts of the 5 MW rice husk power plant in the Ikwo cluster is summarized below:

Environmental impacts:

- Since the electricity generated by the project activity is biomass based, it is CO_2 neutral. Hence, there is no CO_2 emission into the atmosphere.
- Compared to diesel power generation, the project activity reduces about 501,936 t CO_2e emissions globally.
- The power plant replaces the use of diesel gensets, which results in poisonous smoke and cause huge health impacts.
- The project utilizes the biomass, which are otherwise being dumped or open burnt. Dumping of biomass results in methane emission and open burning causes environmental pollution. Therefore, the project is environmentally beneficial.
- The particulate emission from the biomass power plant is controlled using high efficiency ESPs. Hence, the air pollution impact is within the limits that the country specifies.
- The water required for the power plant is treated properly and used for plantation inside the boundary. Hence, there is no water pollution due to discharge of wastewater into nearby streams, rivers etc.
- The ash generated from biomass is collected properly and used as a soil conditioner. Thus there is no land pollution due to ash disposal.
- Trees are planted around the power plant, which acts as a sound proof. Hence, the noise pollution is greatly minimized.

Socio-economic impacts:

- During construction of the power plant, several local workers will get direct job opportunities and indirect job creation will also taken place in and around the construction site.
- The project can bring around 50 direct job opportunities during operation phase of the power plant. in addition to that, there are some indirect job opportunities also. Hence, economic condition of the people will be enhanced.
- The rice mills are gain profit from the sale of rice husk to the power plant.
- The project is expected to save large quantity of diesel and the avoided spending on diesel can be diverted for other economic/productive activities.
- Rice husk power generation will bring down the energy cost of rice milling and will help the rice mills to remain competitive.
- As the rice mills become competitive, more and more farmers will enter into rice cultivation and the overall rice production and export possibilities of the Ebonyi state will increase.
- Overall job creation in rice milling and paddy cultivation will keep on increasing in the state due to the impact of power plant.
- The public health and aesthetic quality of the area will be improved.

Appendix 1

Meteorological Data

a) Annual Rainfall Data from the year 1988-2008

January

Days	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.2
3	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	1.6	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0.6	0	0	0	0

21	2	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0
22	5.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	32.4	0	0	0	0	0	43.9	0	0
26	0	0	0	0	0	0	33.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

February

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.7	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	8.7	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.4	0	9.4	0
10	0	0	0.5	0	0	0	0	0	0	0	6.1	0	0	0	2.5	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	1.9	0	0
16	0	0	0	0	0	0	0	0	0	0	0	3.5	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	12.2	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Tr	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	34.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23.5	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	0	0.6	0	0	0	0
27	0	0	0	1.4	0	5.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	2.2	0	0	0	0
29	0				0				0				0				3.6				0

March

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	3.7	0	0	2.8	0	1	0	0	0	0	0	0	0	0	0	2.9	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.8	0.6	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0
7	5.8	0	0	0	0	0	0	0	0	0	0	0	0	18.5	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	1	0	0

9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.6	16.7
10	0	0	0	0	0	0.1	0	0	1.9	0	0	0	0	22.3	0	0	0	0.7	0	0	0
11	0	0	0	0	0	0	0	0	0	5.6	0	0	0	0	1.3	0	0	0	0	0	0
12	0	0	0	0	0	39.9	0	0	0	0	7.1	28.7	0	0	0	0	0	0	0	0	0
13	7.4	0	0	0	0	0	0	0	0	21	9.1	0	0	0	0	0	0	0	0	0	0
14	0	0	0	28.3	13.9	0	2.8	0	11.7	0	2.9	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0.5	0	21.7	0	0	0	0	0	0	0	0	0	0	0	0	4.7	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.1	0	0	0	0	0	0
17	4.8	0	0	0	0	0	0	35.8	0	0	0	0.5	22.3	0	0	0	0	0	26	0	39.3
18	0	0	0	26	32.5	0	0	3.2	0	43.2	0	0	0	1.7	0	0	0	0	0	0	0
19	2.9	0	0	0	0	0	0	0	0	0	0	0.3	0	0	4	0	0	0	0	0	0
20	0	0	0	0.8	60.1	0	0	0	0	0	0	0	10	0	0.2	0	0	19.5	0	0	0
21	0	0	0	0	5	0	6.9	51.2	7.1	0	0	0	0	0	0	0	0	0	47.2	0	0
22	0	4.4	0	0	0	0	0	0	0	26.4	0	0.5	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.7	0	0	0	0	41.8	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6
25	0	0	0	0	0	0	0	0	0	0	4.6	0	0	0	0	0	0	0	0	0	0
26	1.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	2.1	0	0	0	0	0	0	0	0	21.6	0
28	0	0	0	0	0	0	0	0	27.9	0	0	0	0	0	0.3	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	4.4	0	0	0	29.5	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Tr	0
31	0	0	0	4	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0

April

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	1.4	0	0	70.2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	9.8

2	0	0	0	0	0	0	46.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	57.4	0	0	0	40.2	0	0	0	0	0	0	0.1
4	13	0	0	0	29.8	0	0	0	0	2.6	0	0	1.5	0	0	0	0.6	0	56.1	0	19.7
5	0	0	0	0	0	42.8	0	0	0	0	56.3	39.2	0	8.9	0	0	0	0	0	0	0
6	1.6	0	0	0	0	0	0	0	0	22.7	0	3.6	20.6	0	0	0	38.6	0	0	0	43.6
7	0	0	5	21.6	2.2	0	35	0	0	0	0	0	0	0	13.7	0	17.1	0	0	0	9.1
8	0	0	49	0	0	0	0	0	0.2	0	0	0	0	0	11.1	0	0.8	0	0	0	0
9	0	0	0	18.1	0	0	0	0	0.8	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	1.1	0	0	0	0	0
11	1.6	0	0	0	1.5	0	0	0	78.1	2.3	0	0	0	79.6	0	9.6	0	0	0	0	0
12	2.1	0	0	0	63	0	0	0	0	0	0	0.2	0	18.4	0	0	0	0	0	0	3.2
13	0	0	0	14.5	0	0	0	0	0	0	0	0	0	0	30.5	0	0	0	0	0	0
14	0	28.8	0	0	0	0	0	17.2	0	0	0	0	4.6	0	0.4	11.4	1.2	11.7	0	0	0
15	0	0	32.3	0	0	39.5	27	0	0	18.8	0	0	7.6	49.8	1.8	0	0	0	0	0	0
16	0.9	0	0	0	27.6	0.2	0	37.1	40.3	0	0	12.4	0	2.6	0	0.7	0	0	0	0	15.8
17	0	0.2	0	19.4	0	0	0	0	0	0	0	0	0	14.4	0	33	0	0	0	0	4.7
18	0	0	0	0	0	0	0	0	0	0	40	0	0	13.6	0	6.4	0.2	0	12.4	0	3.4
19	52.2	67.9	0.4	0	0	0	0	0	10.1	68.8	2.3	0	0	0	0	0	0	0	0	18.8	0
20	0	5.1	13.4	0	27.9	0	0	8.7	0	4.8	2.2	0	32.2	0	40.8	0	21.8	0	2.1	2	0
21	0	40.1	0	0	0	3.4	7.6	0	0	14.4	2.6	0	0	0	0.3	0.6	69.3	0	0	0.7	0
22	2.5	0	9.8	0	0	24.4	0	0	0	8.9	0	18.8	0	0	0	0	0	1.3	0	0	2.2
23	0	0	0	0	0	0.2	0	72.7	0	0	4	5.1	0	0	60.2	3.2	0	22.6	0	0	0
24	0	4	70.4	28.1	0	0	0	8	0	0	0	0	8.2	0	0	5.5	0	0.6	44.6	0	0.5
25	0	0	0.6	0	0	0	6.2	0	0	0	0	0	0	73.4	0.3	0	3.6	35.9	12	8.8	0
26	0	0	0	0	0	35.8	12.8	0	0	0	24.4	0	0	0	0	0	0	0	0	0	6.7
27	20	0	0	19.7	0	0	2.6	0	0	53.4	12	19.5	0	0	0	0	0	0	0	59.4	26.2
28	0	0	0.6	0	48.9	2.6	9.2	1.7	0	0	0	4.2	8	4.6	0	0	31.6	0	0	4	0
29	0	21.8	0	6.3	0	0	0	1.4	30.8	7.2	17.3	0	0.5	0	0	0	0	6.5	11.2	12	0

30	0	0	0	0.2	0	0	4.2	47.3	0.6	0	0	0.6	118.1	0	0	3.1	0	37	0	0	46.6

May

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0	15.1	0	0	0	11.3	24.5	13	12.5	81.7	34.1	0	0	0	4.4	0	0	0	0	15	0
2	0	1.6	0	0	0	0	14.6	0	0	106.1	0	0	0	0	1.5	0	0	0	37.8	9	14.8
3	0	0	0	0	0	4.8	1.7	0	0.7	31.5	19.3	0	0	26.9	31	0	0.4	0	0	0	0
4	26	24.1	0	0.4	0	24.8	31	27.7	0	0	0	0	0	0	0.2	0	0	50.9	0	0	0
5	1.5	0	12.6	6.2	0.6	0	0	0	17.3	5.7	0	0	0	16.4	16.2	0	34.7	6.8	0	29	0
6	0	9.1	0	0	0	9.8	0	0	0	25.7	0	20.5	0	0	0	0	0.6	0	0	0	0
7	0	9	0	0	17.4	0.4	0	43.5	0	0	0	0	3.5	0	0	0	0	0	0	0	21.8
8	0	1.6	4	0	0	0	0	0	0	8.3	0	0	0	16.2	0	0	13.2	62.7	0	100.4	42.8
9	0	0	0	33.3	22.8	0	10.5	0	7.5	0	51.4	5.3	65.5	1.3	27	0	0.7	28.4	29.8	0	0
10	3.8	43.2	0	0	0	0	11.1	19.6	0	0	0	26.1	0	0	46.4	0	31.8	2.8	0	0	11
11	0	6	0	11.6	0	0	10.8	9.6	0	0	0	20.7	0	0	0.2	2.5	1.8	0	0	49.8	7.9
12	22.1	0	0	0	11.1	0	0	0	0	0	0	0	0	40.1	0	0	0	0	5.6	0.6	14.5
13	0	0	0	2.2	0	17.1	4.4	4.7	0	0	0	15	0	0	0	0	9.3	0	0	0.5	0
14	0	0	27.5	83.7	0	9.6	0	0	21	0	8.7	0.6	0	0.4	18.3	0	12.6	0	29.2	0	5.8
15	0	0	0	5.7	0	0	9.7	0	8.6	0	0	0	0	0	0	0	2.1	0	15.3	0	0
16	0	44.1	15.2	14.8	16	0	0.1	39	0	0.6	0	43.6	11.8	34	10.8	76.1	0	0	6.2	0	0
17	0	0	0	23.1	5.3	0	11.8	0	5.4	18.5	0	0	0	1.4	0	14.2	58.1	0.6	0	0	0
18	2.6	0	1.3	4.9	0	0	15.6	12.6	1	0	0	0	0	0	0	12.4	24.6	0	0	23.3	17.7
19	3.2	0	1.7	2.2	4.3	3.5	0	0	0	9.4	17.9	40.1	47	0	0	0	0	0	13.9	2.8	0
20	0	0	0	0	6	0	0	0	32	9.4	0	0.2	30.5	4.5	0	28.6	12.6	0	20.3	0	16.5
21	0	20.1	0	10.9	11.8	8.6	16.4	80	0	36.1	0	0	0	7.9	46.8	0	0	0	0.3	0	4.1
22	0	4	0	10	12.3	0	0	0	20	16.3	34.1	0	5.9	21.6	2.3	11.9	0	0	29.4	0	0
23	1.6	32.4	9.4	12	0	0	0	0.3	9.8	0	6.6	0	1.5	42.5	0	0	0	0	0.2	0	42.5

24	0	40.1	6.1	6.6	0	15.9	0	0	0	0	0	0	8.2	0	0	0	0	0	48	26.7	0
25	0	28.3	0	6.5	65.5	0	0	0	59.1	0.2	0	24.6	0	0	0	50	44.6	0	23.6	0	Tr
26	36	0	0	4.4	9.5	0	7	0	53.3	8.3	0	0	0	26.6	0	0	0	0	1	0	19.6
27	4	0	0.8	11.5	2.7	0	3.3	0	0	18.3	11.4	0	102	0	8.3	0	42.6	2.2	30.7	18.9	31
28	32	0	10.7	7.3	8.7	0	3.2	0	1.8	0	0	0	0	0	6.3	0	0	0	0	0	0
29	0	0	0	2.7	0	0	0	6.1	25.7	0	5.2	4.5	0	7.8	0	0	1.9	0	64.4	0.4	0
30	17.1	0	0	4.8	0	0	0	0.9	1.5	0	0	22.3	0	0	0	38.6	13.9	1.2	0.7	48.6	16.4
31	5	0	0.4	81.6	0	4.1	35.5	6.9	0	0	0	0	81.6	26.2	0	0	0	14.4	18.6	0	14.8

June

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	22.5	0	0.5	0	0	36.1	0	0	2.5	0	0	0	0	23.4	0	21	48.4	0	0	0.6	0
2	0	17.3	22.4	3.8	0	0	0	3.5	5.9	12.3	4.4	0.4	56.9	0	1.6	0	16.3	4.4	0	0	26.5
3	4	0	2.6	0	15.8	0	0	0	7.3	12.6	0	0	0	0	55.9	6.7	4.8	1.4	26.5	53.7	0
4	0	0	23.5	28.9	45.9	16.1	37.3	0	0	0	0.5	44.6	0.4	1.1	3.3	0	0	0	0	60.2	0
5	13.4	0	0	0.2	1.5	0	24.4	51.3	0	0.9	14.4	0	18.6	1.3	37.4	1.7	0	114.2	0	0	0
6	0	0	0	64.4	0	0	0	0	4.6	0	0	0	0	21.4	0	9.7	0	0	56.2	0	0
7	0	0	27.4	7.3	48.2	3.7	1.7	7.3	0	0	33.6	0	11.1	0	14.7	0	0	0	14.6	0	0
8	30.9	0	7.9	0.4	0	0	31.7	0	0	30.6	0	83.2	0	8	0	15.4	4.8	3.4	40.4	0	70.8
9	0	0.7	0	0	39.6	2.2	0	31.6	0	0.8	0	12.9	0	0	22.1	16.8	0	0	9.9	0	0
10	0	2.8	0	1.6	0	40.8	0	0	2.8	0	0	31	4.4	5.8	0	0	1.3	0.4	0	0	0
11	0	8.5	0	0.9	0	0	0	46.1	0	0	19.7	10	36.8	0.4	19.2	0	1.4	85.7	0	0	0
12	0	0	16.3	0	11.3	0	0	55.2	0	39.7	0	0	1	5.6	9.4	8.2	8.9	18.6	0	1.6	0
13	18.6	25	0.4	0.4	0	30.5	0	20.5	72.3	14.5	0.9	26.8	0	16.6	0.7	4.5	7.2	2.4	0	3.3	5.4
14	0	0	0	13.2	39.7	0.4	0	0	0.7	1.3	19.4	13.1	0.8	9.2	0.6	8.2	0	0	13.2	11.6	0
15	2.5	10	55.6	2.9	24.3	0.7	0	10.6	0	4	0	0	2.8	0	3.8	39.9	0	0.5	1.4	0.6	29.8
16	30.2	0	12.4	0.2	28.1	0	0.3	0	0	0.4	0	0	2.1	0	0	36.9	25.5	1.4	32.6	0	6.4

17	39.9	0	0	10.5	0	8	4.4	0	0	0.7	37.2	62.9	0.5	2.1	29.6	1.7	0	3.4	36.6	50.6	25.1
18	0	0.5	7.9	37.6	0	0	27.8	7.2	0	13.8	0	0	0.7	0	8	10.2	0	0	0	15	0
19	0	0	8.6	21.2	0	0	1.8	1.6	0	2.2	0	1.3	2.4	0	8.6	0	0	15	0	9.8	0
20	0	1	5	9.8	0	0	0	0	0	0	36.5	0	3.1	0	0	0	48.7	0	31.2	0	0
21	0	3.5	0	18	0	7.1	7.5	0	9	0	11	0	1.8	6	0	25	0	0	4.7	Tr	
22	0	0	30.4	0	0	12.5	1.3	0	0	4.3	0	0	17.7	0.6	0.4	5	0	0	0	0	
23	0	5.4	0	0	30.8	1.6	1.8	13.5	43.5	12.7	0	0	3.4	0.4	4.4	0	0.4	0	0	0	
24	0.2	0	0.7	0	0	21.5	0	42.2	0	174.4	14.1	14.8	0	0	0	7.9	0	0.7	43.2	Tr	
25	0	14	0	0	34.4	0.2	0	7	0	0	0	0	22.2	12.7	1.1	8	0	0.3	0	48.2	
26	14.2	0.1	0	0	20	0	0	39.3	41.4	19.3	16.8	0	10.8	0	28.6	8.9	0	2.4	28.1	2.9	
27	0	28.6	42	14.4	10.8	46.9	0	0	46.6	0	40	0.8	3.6	0.3	31.1	0	6.4	2.1	0	Tr	
28	36.1	13.7	0.6	0	2.9	7.3	0	0	0	0.5	0.3	14.4	0	73.9	0	47	0	0	0.6	0	
29	5.7	0.1	0	0	0.7	1.6	0	0	51.6	0	25.6	0	2.1	0	15.8	1.4	48.2	0.4	0	38.2	
30	2.1	51.4	15.2	9.1	0	26.5	0	19.8	1.4	0	10.6	0.6	2.9	0	0.1	2.9	0	1.6	0	0	

July

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	4.4	0	8.6	32.8	0	15.3	12.8	0	0	0	0	1.3	2	0	12.4	0	0	25.8	1.2	0	
2	0.3	31.6	120.1	11.2	5.2	8.4	0	0	3.9	55.8	0	15.4	0	0	5.9	2	0	25.3	85.5	2.6	
3	0	3.4	114.9	0.5	12.5	0	0	45.5	2.4	6.9	6	0	15	0.7	0.5	0	0	9.6	5.1	15.8	
4	0	0	0	1.8	0	7.7	34.2	14.7	13.1	0	0	0.2	5.6	0	7.7	0	0	1.4	0	0	
5	0	5.7	1.4	0	1.2	0	0	0.4	27	0	0	0	2.1	0	7.4	0	1.3	9.4	0	0.6	
6	0	4.4	5.7	1.8	114.5	1.4	0	3.4	0	0	124.8	6.2	0	26.6	1.2	5.2	0	2.5	8.8	Tr	
7	0	0	64.4	0	57.1	0	0	21.1	0	0	4.3	5.5	0	8.3	39.6	9.9	0	0.2	0	0	
8	10.3	0	4.7	2.3	11.1	7.8	27.7	16.7	24.6	0	8.7	5	0	0	0	0	15.9	17.8	0	0	
9	13.8	30	1.3	1.6	0	0	6.3	1.6	0	0	0	0	0	0	0	7.6	2.1	33.2	5.1	1.2	
10	0	0.3	0	8.3	0	12.9	0.3	58.6	0.3	0.8	0	0	0	18	9.6	0	12.1	14.1	0	37	

11	66.7	0	5	24.6	12	2.4	0	0	11.2	25.1	19.6	0	0.2	19	6.4	10.3	11.7	0	0	Tr	
12	7.5	6.3	2.5	4.2	0	20.3	6.9	0	22	6.2	4.6	9.3	24.5	24.3	0	38.2	9.8	0.6	0.8	4.1	
13	0	0	0	60.1	16.1	0	2.4	0	0	0	34	0.7	1.4	1.7	0	0	0	5.2	4.7	25.1	
14	0.4	12	0	5.1	4	0	0	0	158.1	5.4	5.3	2	2.6	0.4	0	19.9	22.1	0	8.2	2.4	
15	24.1	0	6.9	0	0	0.9	13.9	78.3	0.1	40.5	19	6.2	0.2	16.7	4.7	57.8	0	0	0	2.3	
16	20.8	0	6.6	2	0	3.2	23.1	0	0	0	0	1.2	14.4	0.6	0	40.3	27.6	23.5	0	2.7	
17	3.6	5	0	0	0.8	2.4	7.5	12.7	0	0.3	0	2.6	0.4	0.5	0	9.2	21.3	0	11.8	28.4	
18	0	27.7	9.8	30.5	10.6	0	0	2.8	88	0	11.3	0	2.4	0	1	0	6.2	7.6	53.3	1.2	
19	3.8	5.1	3.8	28	2.7	0	8	4.4	0	0	0.8	0	115.9	21.8	1.4	6.2	5.6	3.6	43	47.1	
20	0	0	39.6	33.6	0	0	19.5	32	0	0	4.4	0	3	4	2.4	28.6	1.1	2.4	42.8	0	
21	0	0	49.2	11.9	0.8	12	2.6	14.1	0	0	0.4	4.8	0	4.4	48.3	7.5	16.8	0	1.2	Tr	
22	0	0	25.8	0	0	0.4	11.2	1.3	0	0.5	0.2	32	0	0	0	0	0	0	17.9	18.6	
23	0	1.5	0	0	10	12	0	2	0	20.1	6.5	26	1.7	0	0	0	4.9	0.4	0	4.8	
24	14.1	0	0	20	1.9	3.7	7.2	0	0	0	0	3.7	3.1	0	5.2	0	0	6.3	2.1	0.4	
25	7.6	4.8	0	11.8	1	7	3	0	1.3	0	0	26.3	3.5	0	0	0.4	11.5	2.9	10.7	1.9	
26	2	5.8	1.7	7.4	41.9	0.2	0	3.5	2.6	1.5	0	1.2	0	0	2.4	2.9	1.2	58.9	0.4	Tr	
27	8.6	0	32.2	0	4.2	0	0	0	0	1.4	0	0	6.6	2.8	0.4	0	62.9	2.7	44	2.9	
28	2	0	0	0	0.3	2.8	0	17.6	1.8	0.7	1.8	55	41.5	0	0	0	0	3.7	49.9	90	
29	10.8	10.5	0	4.7	0.6	41.3	0	0	0	13.4	3.3	0.8	31.3	2.2	86.7	8.7	36.6	19.1	0.2	1.2	
30	16.4	0	2.8	16	2.2	22.7	22.8	0	3.2	13.3	3.8	1	0.7	0	13.4	108.3	14	1.4	23.4	0	
31	2.1	8.1	1.3	0	2.3	1.9	6.6	9.5	8.7	34.9	0.4	0	20.3	0	6.7	37.4	0	0	0.4	0	

August

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.1	0	18.6	5.3	2	27.4	2.1	3	7.5	3.3	1.3	0	0	2.2	7.9	0	0	0	0.7	0	17.6
2	1.1	0	3.5	0	0	0	56.2	0	16.5	1	0.4	0	15.9	9.8	0	0	1.2	0	17.8	18.6	32.6
3	0	50.7	77.9	0.2	0	54	0	8.4	5.6	0	0.6	0	1.2	1.8	0	0	0	0	5	22.5	14.6

4	0	30.5	0	0.4	14.8	79.7	0	52.2	0	0	0	0	1	8.3	1.3	0	0	0	0.7	0	10.1
5	0	25.3	3.5	2.1	0	6.1	0	4.8	33.6	14.5	0	0	0	1	0	0	55.1	0	0	0	0
6	0	20.2	0.4	35.1	5	0	1	3.3	2.2	0	0.6	0	2.2	0	20	23.8	4.8	0	0	0	5.6
7	0	69.1	0	0	18.1	1.3	0	0.7	0	0	0	0	5.6	4	0.6	0	0	0	8.9	Tr	31.3
8	0	5.2	6.2	0.5	5.1	2.8	14	15.3	0	0	0	0	66.4	24.6	0	0	0	5.4	0	1.2	0.8
9	0	1.1	31.4	0	0	0	2.2	21.5	8.7	0	0	0	0	0	3.1	8.2	0.7	0	0	0	0
10	0	6	22.8	0	0	1.9	18.4	87.2	0	0	0.8	0	0	0	10.4	9.5	3.4	0	2.3	0	6.6
11	3.7	0	0	0.9	37	0	4.9	12.6	0	0	32.5	8.6	1.3	0	2.3	0.3	0	0	26.2	24.2	tr
12	0	10.2	0	10.9	0	11.4	13.1	4.2	0	8.2	39.6	4.6	0.2	0.6	0	44.6	0	53	0	8.2	6.2
13	0	22.9	10.2	28.2	1.6	1.2	0	3.8	3	0.5	3.3	17.6	14.3	21.6	0	0.9	0	12.8	0	8.6	0
14	4	33.9	44.5	4.8	0.5	6.2	37.4	11.1	10.5	29.1	2.2	8.5	1.2	13.6	4.5	0	0.3	0	0.3	7.8	2.8
15	0	6.8	0	5.7	9.7	17.1	2.7	2.7	0	29	1.7	0	6.8	5.1	0	42.4	3.7	2.8	19.6	0	78.3
16	30.5	0.6	17.8	19.1	5.1	0	3.6	13.5	28.5	0	0	19	4.4	2.5	1	15.6	3.1	0	0	0.6	32.4
17	0	7.5	0	27.7	0	12.7	0.7	0	8.8	0.5	3.7	9.4	14.2	0	0	70	0	78.6	0	Tr	4
18	64.1	0	0	5.1	0	20.2	18.6	0	39	0.2	0	28.8	11	0.6	3.7	0	0	0	0	17.4	0.9
19	0.4	53.6	1.1	40.8	0	5.6	25	53.7	16.2	13.3	3.5	2.4	0.8	0	22.2	7.1	0	0	0	30.6	tr
20	0	11.8	0.4	14.2	0	0.5	5.9	4.1	20.7	0.3	0.2	11.4	0	16.9	2.1	0	0	11.8	0	0.6	7.6
21	15.9	0.7	0	6	0	0	7.9	30.8	0	0	0.9	4.3	2.6	0.1	3.2	6	1.7	3.7	9.3	1.1	5.4
22	0.4	4.1	0.5	1.1	0.8	0	34	32.6	0	27.1	0.5	1.4	9.4	0.3	10.6	28.8	10.5	2.9	0	16.9	2.2
23	0.5	1.7	24.1	12.7	0	19.8	12.1	10.1	15.2	3.4	0	28.9	42.6	0	0	0	0	0	0	0.2	10.4
24	39.1	17.3	45.9	0.2	17.4	0	0.2	10.9	0	0.4	0	1.6	0	0	0	0	28.6	0	0	Tr	tr
25	2.3	8	0	21.6	1.9	2	0	24.9	0.6	37.3	0.7	27.9	1.7	0	6.6	5.2	0	1.6	53.2	3.8	0
26	0.3	6.6	31.8	13	3.3	0.8	31.2	2.4	31.4	5.8	0	5.1	0	0	1	11.5	0	1.3	1.9	37.6	1.2
27	5.9	13.1	8.1	4.1	2.9	29.1	30.2	3	0.5	25.6	0	18	6	2.4	0	0.6	3.1	1.1	0.3	2.5	7.4
28	0	5.7	0	0.7	24.1	35.5	4.4	0	0	12.7	3.4	2.7	1.8	13.6	3.7	0	4.5	50.5	0	49.3	39.6
29	0	0.8	0	3.4	0	14.9	0	0	2.5	15.2	0.3	0	24.4	0.4	0	0	16.4	4.7	11.6	0.2	2.6
30	29.3	0	0.4	0.7	0	5.4	10.2	0	16.2	7.6	0	0	96.5	1.2	12.5	0	2.6	0	4	3.2	7.6
31	28.8	0	10	0	0	34.2	52.2	18.3	1.2	0	0	0	0.3	0	5.2	15.7	34.4	61.8	26.5	0	0.8

September

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	3.8	0	0	8.6	7.9	1.8	0	7.4	22.7	53.8	1	0	3.1	28.7	0	10.4	10.7	17.3	2.1	Tr	0.8
2	0.4	22	19.2	0	58.6	1.1	0.7	39	10.6	11.2	24.6	15.1	0	0.2	0	5.2	21.7	0	13.8	0.3	tr
3	53	2	23.8	0	7.3	0	0	0	0	0.6	7.9	11	0	2.1	0	0	4.3	2.3	0.6	17	4.2
4	0	0	3.3	9.6	3.5	0	0.7	0	0.2	0	0	4.5	0	1.6	4.9	0	8.3	0	0	11.4	10.9
5	23.2	0.5	0	0.7	5.4	17.4	0.2	0	0	2.2	0	7.8	0	0	6.8	17.1	6.2	4.8	5.1	0	2.8
6	23.7	22.3	7.3	1.1	9.4	12.3	19.8	7.6	0	0	0	0	32.9	2.5	8.2	10.9	0	5.2	8.4	23.6	0
7	0.6	10.3	0.6	16.7	3.5	0	17.8	13.6	0	59.9	2.3	4.5	23.4	0	0	46.9	3.2	0	3	25.7	tr
8	6.9	12.2	0	0.7	1.4	4.1	2.4	15.7	6.4	6.4	1.6	2.9	0	4.8	15.8	0	19.6	0	46.5	0.2	0.9
9	2.6	17.2	0	0	3.5	52.3	13.8	0	32.7	0.4	0	47.9	0	0	0.8	0.4	0.2	0	9.6	Tr	22.8
10	1.4	4.2	30.5	17.2	2.2	0	3.1	0	2.2	6.7	43.9	3.1	77.2	0	4.2	0	0	71.1	4.4	3.2	19.6
11	4.5	5.8	86.2	0	0	0	0	11.7	5.7	1.6	0	0	11.9	30.6	39.1	0	23.7	1.2	17.6	0	19.6
12	0	0	14.3	19.6	0	50	24.2	1.7	0.6	39.6	0	0	0	7.4	3.3	0	0.1	0	13.3	Tr	16.1
13	1.4	0	1.4	0	2.2	6.7	0	0.3	0	0	11.8	7.8	0	2	2.7	47.2	0	0.6	0	2.7	0
14	0	15.6	4.6	0	0	0	0	0	8.7	0	18.9	17.6	8.7	58.5	1.7	0	32	46.7	5.9	9.3	0
15	16.5	7.3	2.2	23.8	26.6	5.4	5	3.7	0	14.3	4.9	0	21	1.4	0	25	1.6	9.4	27.3	0.8	66.4
16	0	0	23.5	0	4.9	0	30.1	27.4	35	0	0	31.6	0.9	0	0	0	0	0	2.9	12.6	5.4
17	35.1	0	0	0	50.7	0	0	0	0.4	0	1.1	0.4	7	0	66.9	40.1	50.8	0	0	61.1	1
18	0	14.9	41.6	1.4	1.2	4.5	6.3	0.6	0	55.8	5.3	0	10.4	1.3	5.7	3.4	0.8	27.1	12.6	0.8	5.6
19	0	1.1	0	12.2	5	24.9	7.6	6.6	6.2	0	0	1.1	0.2	30.5	0	1.3	1.2	2.5	0	0	15.8
20	16.6	0	5.3	0	17.7	0	52.4	0	0.1	13.4	42.3	19.8	4.3	12.6	13.7	23.8	27	5.4	0	0	44.1
21	10	0	0	31.5	4	0	1.2	2.5	0	4.7	1.3	1.1	28.9	7.3	0	3.4	13.2	10.7	1.6	26.6	2.2
22	14.4	11.6	0	0	14.5	0	9.9	4.9	0	24.8	37.2	0	0	20.9	30.4	20.1	11.1	6.8	0	16.9	0
23	36	3	16.3	54.2	0	33.1	0	5	25.5	35.1	16.3	9.3	21.4	12.5	2.2	6.2	6.5	1.1	1.3	1.6	tr
24	14.1	2	1.4	4.4	0	0	0	2.5	0.1	49.1	4.5	0.7	1.7	0	0.7	1.8	3.9	26.8	12.6	0	0

25	3.7	19.5	16.1	23.1	0	11.6	74.1	0	2.4	0	0	0	0	56.3	0	0	0	2.2	0	28.8	0
26	0	0	0	0.2	0	0.7	14.8	2.7	4.3	6.6	6.7	0	0	6.2	9.3	36.2	5.9	0	19.3	13.2	42.9
27	12.4	15.7	3.4	3.2	0	5	39.9	31.3	5.7	1.4	0	6	45.5	63.3	0	0	0	42.4	0	9.6	24.6
28	0.1	3.3	0	1.7	11.9	12.6	0	8.2	0	4.7	1.1	0.5	0	11.8	22.6	18.6	9.5	0	6.4	8.7	1.4
29	0	21.3	0.8	0.6	8.3	0	0	0	0	0	2.6	2.4	17.2	3	0	16.4	0	0	3	5.6	25.4
30	4.8	5.6	15.7	0	0	0	7.9	0	6.8	0	21.3	0	24	42.4	31.9	0	10.8	0	44.5	20	tr

October

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0	0	0	10.9	0	0	0	4.2	0	0	6.6	0.5	7.5	0.6	44.4	0	0.6	5.2	0	0	0
2	0.5	0	73.3	13.2	0	12.4	14.1	0	8.6	0	0	0	3.5	0.4	20.2	0	0	0	15.7	4.3	19.2
3	0	16.9	3.1	23.4	0	0	0.8	0	13.1	4.8	0	0	0	0.5	68.9	25.5	17	32.6	5.7	14.7	0
4	7	0	45.6	0	0	9.9	0	46.8	9.9	0	0	39.3	0.3	4.5	0	0	0	31.2	0.4	0.2	9.1
5	29.1	25.8	32.6	12.3	0	3.6	0	33.5	0	61.9	20.2	0.4	0	10.3	0	1.8	0	3.4	25	0	2.2
6	32.8	0	34.8	1.7	0	0	1.9	1.2	13.8	5.6	0	49.4	10.8	1.1	0	0	6.2	20.8	3.8	4.5	0
7	1.5	3.6	15.2	3.6	0	0.7	0	3.1	0	0	0	0	2.2	32.2	0	0	29.1	5.6	2.3	0	0
8	5.2	0	0	0	5.2	6.2	0	5.3	17.8	0	7.3	13.9	5.5	0	13.2	0	0	8.2	0.7	Tr	0
9	4.7	0	4.4	0	5.6	2.6	0	9.6	2.6	0	4.9	0	0	3	1.4	13.2	0	0	24.8	28.3	tr
10	0	0	20.2	0	0	0	0	0.3	0	0	6.2	0.2	9	31.8	1.3	0	0	13.4	17.2	30.1	23
11	23.2	17	0.5	0	2.2	0	3.7	2	7.6	1.5	9.9	0	9.3	30.3	0	8.5	34.2	0	0	4.9	tr
12	1.9	3.4	0	0	3	0	1.6	13	10.8	0	0	2.8	92.4	0	4.4	0.7	43.6	0	11.9	0	1
13	0.4	25.1	14	0	4.8	4.1	7	0	30.8	0	0	7	27.2	0.2	0	54.8	0	3.7	3.8	0	0
14	3.4	0	5	0	0	11.3	0	0	0.3	3.2	2.5	33.7	0	0	0.6	1.6	16.6	0	0	Tr	0
15	0	0	2.7	40.5	0	0.3	0	21.7	0	0	0	7.6	0	0.2	75.8	0.7	0	7.9	0.7	4	0
16	0	37.2	0	69.5	0.3	0	0	0	29.7	18.3	21.8	8.8	0.3	3	33.7	0	0	4.6	31.8	9.2	12.2
17	0	17.8	3.9	49.1	2.5	0	30.4	0	0	0	1.5	0	11.3	0	1.1	0	0	0	0	0	15.8
18	0	4.5	0	0	0	0	11.8	0	82.6	0	0	6	0	0	10.8	31.9	0	33.8	22.2	4.8	0

19	0	44.3	0	0	42.5	6.2	15.8	0	0.6	19.2	36.4	0.4	0	0	0	1.7	19.2	0.6	17.3	Tr	0
20	56.1	0	0	0	0	0	2.3	21.9	32.8	22	0.1	0	0	0	0	0	0	0	13.2	31	1
21	0.2	0	0	1.3	8.3	0	0	0	0.3	22	0	0	0	0	0	48.5	0	0	1.4	2.2	0
22	16.1	1.1	0	0	0	14.2	0	24.5	0	2.3	71.2	13.4	0	0	23.8	0	0	0	0	20.1	12.9
23	0	0	10.7	7.9	4	0	0	0	0	18.8	12.6	13.3	0	0	0	0	61.3	0.4	17.2	0	0
24	0	0	52.8	0	0	0	0	10.6	12.5	0	0	7.5	0	0	25	0	1.5	32.4	0	50.7	0
25	0	0	0	0	0	0	1.3	0	28.8	0	0	23.9	0	0	0	0	0.8	0	0	4.4	0
26	0	0	0	12.7	0	0	2.7	0	0.8	6.2	0	0	4.6	0	0	2.4	0	0	0	0	0
27	21.7	0	0	3.2	0	1.4	0	0	0	3.7	0	0	38.1	0	0	0	0	0	2.1	3.2	0
28	2.3	0	0	1.2	18.2	0	57.5	25.9	0	46.9	0	1.6	4.5	0	7.9	0	28	0	0	0	0
29	0	0	0	3	8.7	0	0	6	0	2.7	15.8	37	0	0	0	0	0	0	15.2	23.6	0
30	0	0	0	0	0	0	30.7	0	0	0	0.4	30.9	0	0	0	0	0	0	0	0	0
31	0	20.4	0	0	0	0	0	32.1	0	25.2	0	15.8	0	0	0	36.1	0	24.7	1.3	0	0

November

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0	0	0	0	0	25.8	0	1.6	0	0	0	0	0	0	0	0	0	0.6	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19.8	0	0	0
3	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3.7	0	0	0
4	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	2.5	25.3	0	0	0	0	0	0	0	0	0	1.5	16.2	0	0	0	0	0
6	0	0	0	0	1.5	0	0	7.4	0	0	0	0	0	0	0	0	13.6	0	0	0	0
7	0	0	0	0	0	0	0	0	0	38.5	0	0	0	0	0	0	5.4	0	0	0	0
8	0	0	1.3	0	0	0	0	0	0	0	0	0	0	0	0	23.6	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	29.6	0	0	0	0	0	0	2	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	14.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	42.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

December

Day	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0	0	0	0	0	11.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29.7
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	tr

6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18.9	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	tr
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	6.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	64.8	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	1.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	14.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	4.1	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	5.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0.7	0	0	0	0	0	0	0	0	0	0	0	0	33.1	0	0	0	0

b) Rainfall per year (mm)

Year	Rainfall per year (mm)
1988	1532.4
1989	1643.7
1990	2083.4
1991	1961.9
1992	1706.5
1993	1577.7
1994	1663.1
1995	2170.9
1996	1919.4
1997	2284.6
1998	1496.1
1999	1623.1
2000	2026.5
2001	1677.2
2002	1725.8
2003	1891.0
2004	1770.8
2005	1716.5
2006	2084.3
2007	1891.7
2008	1482.3
Average	1,795.1

Rainfall Highs

Year	Peak Daily Rainfall (mm)
2001	79.6
2002	86.7
2003	108.3
2004	69.3
2005	114.2
2006	85.5
2007	100.4
2008	78.3

Total Number of Rain Days in a Month

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Jan	2	0	1	0	0	0	1	1	0	0	0	3	0	0	0	0	1	0	1	0	1
Feb	1	0	2	3	0	1	1	1	2	0	1	3	0	2	2	0	4	2	3	1	1
Mar	7	1	0	7	4	4	2	3	4	6	5	4	0	5	7	1	1	3	4	3	3
Apr	9	8	9	8	7	9	10	9	7	12	10	9	0	10	10	10	11	7	6	8	14
May	7	13	8	17	11	9	13	9	12	13	6	10	0	13	11	7	14	6	14	9	11
Jun	13	16	18	20	15	18	12	15	13	18	16	15	0	16	22	20	13	19	15	12	6
Jul	19	16	21	22	22	21	18	20	16	17	20	20	0	17	20	18	19	23	22	20	0
Aug	16	25	19	26	16	23	23	25	20	20	18	17	0	20	18	17	16	15	16	20	24
Sep	22	21	20	19	21	15	20	19	19	19	20	21	0	23	20	18	23	18	21	22	20
Oct	16	12	15	14	12	13	14	17	18	16	14	20	0	12	14	13	12	16	21	17	9
Nov	0	0	2	1	3	3	0	2	0	2	0	0	0	0	1	2	4	2	0	0	0
Dec	2	0	5	2	0	0	0	0	0	1	0	0	0	0	0	0	1	2	0	0	2

c) Wind Speed

Year	Average monthly wind velocity in knots											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1988	6	6.2	7.9	7.8	6.1	6.1	6.2	7.1	5.8	4.8	4.6	6.1
1989	9	8	8.1	8	6	4.8	4	4.9	5.1	5	3.8	4.8
1990	5.4	6.8	6.2	7.5	6.7	6.7	6.1	6.1	6.1	5.5	4.5	4.5
1991	6.1	6.7	6.9	6.1	5.1	5.9	5	5.9	4.7	4.6	3.4	6.1
1992	7.2	5.9	5.1	4.6	4.2	4.5	5.6	7.1	5.2	4.8	5.6	5.8
1993	6.7	6.1	7.1	6.7	5.3	5.2	6.2	5.4	4.6	4.6	4.6	5.9
1994	6.1	3.9	7	5.9	4.9	5.3	5.8	6	5.1	4.2	4.9	7.2
1995	5.8	4.8	6.3	5.6	4.7	5.4	5.4	4.6	4.7	4.5	5.5	4.5
1996	4.7	5.9	6.5	6.2	6.3	5.6	5.8	5.5	5.4	5	5.6	4.1
1997	5.1	7.8	5.6	5.6	4.6	5.2	6.5	5.6	5.4	4.7	3.9	5
1998	7.2	5.9	6.4	6.9	5.8	5.2	6.4	0.7	5.7	4.6	3.8	5.3
1999	5.9	0.6	0.8	6.4	5.8	5.2	5.9	0.6	5.1	4.6	3.7	5.7
2000	5.6	6.8	6.6	7.4	5.7	5.4	6	6.1	5.6	4.5	4.3	6.3
2001	5.9	6.6	6.7	6.5	5.7	5.5	5.8	6.3	5.5	4.4	4	4.8
2002	7.2	6.3	7	6.8	5.7	5.5	5.3	5.7	5.2	4	4	6
2003	5.3	5.4	5.9	6.6	6.5	5	5.4	6.5	4.7	4.3	3.5	5.3
2004	5.2	5.4	6.5	6.7	5.8	5.1	5.2	5.8	4.7	4.6	4.8	4.7
2005	7.3	6.5	7.6	7.6	5.6	5.2	5	6.5	4.7	4.5	4.1	4.2
2006	4	5.2	6.2	6.9	5.7	4.9	5.6	6.3	4.9	4.1	4.9	4.4
2007	5	6	5.8	5.7	4.7	5	6	7	5	5	4.8	5.2

Note: 1 Knots = 0.5 m/s

Maximum Wind Velocity

Maximum wind velocity in the past 20years = 85Knots (approx 43m/s).

Wind Direction

It is measurable though not additive. Speaking by season, the dominant wind direction during harmattan period (November - February) in Enugu is mainly northeasterly, with values ranging 10 - 20Kts (5 - 10m/s), with peaks of about 23 - 25Kts (12m/s). During the rainy season, i.e. March - October, the dominant direction is from the southwest.

The speed ranges 5 - 15Kts, and when accompanied by squalls, the maximum gusts reach 60 - 80 Knots (30 - 40m/s). On the diurnal basis, i.e. daily variation, the nights are fairly variable or calm during the rainy season, and the day is from the southwesterly direction. During harmattan however, both night and day experience similar wind regime, that is, northeasterly winds in moderate speeds.

d) Ambient Temperatures

Average monthly maximum temp °C												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1989	33.3	35.2	35.9	33.8	31.1	31.4	29.9	29.4	29.8	30.5	33.3	33.2
1990	33.9	35.3	37.5	34.4	32.1	30.7	29	29.3	29.8	30.7	32.2	32.1
1991	33.5	35.3	34.5	32	31.2	31.1	29.3	29.2	30.2	30.3	32.4	32.1
1992	32.5	35.9	34.4	33.2	31.9	29.8	29.3	28.8	30	30.8	31.6	33.3
1993	33.3	35.2	34.3	33.3	32.1	30.7	29.6	29.1	30.3	31.1	32.4	31.9
1994	32.6	35.1	35.7	33.3	31.7	30.9	29.6	28.2	30	30.9	32.7	33.1
1995	33.6	35.5	35	33.9	31.6	30.5	29.5	29.4	30.6	30.8	32.7	32.8
1996	34.4	35	34.4	33.7	32.1	30.7	29.7	29.5	30.1	31.1	32.7	33.1
1997	33.7	35.2	34.9	33.6	32	30.6	29.6	29.6	30.6	31.4	33	33.4
1998	33	36.9	36.4	35	33	32	30.3	29.6	30	31	33.9	33.5
1999	33.9	34.6	35	33.6	32	31	30.1	30.1	30	31.1	32.7	33.1
2000	34.3	34.3	36	33.8	32.6	31.1	30.1	29.3	30.4	31	33.4	33.3
2001	34.2	35.5	34.6	33.3	32	31	29.8	28.8	30	31.4	34.1	34.6
2002	33.8	35.7	35	33.3	32.8	31.1	30.5	29.7	30	30.8	33	34.1
2003	34.6	36.1	36	34.4	33.3	30.4	30.4	30.5	30.4	32.1	33.4	33.8
2004	33.8	35.2	34.9	33.7	32.1	30.7	29.6	29.5	30.1	31.1	32.6	33.1
2005	32.2	35.8	36.5	36.7	30.3	30.2	29.4	29.8	31.5	33.7	33.2	33.1
2006	34.4	35.9	34.8	32.7	31.9	31	29.5	29.8	29.9	30.6	31.8	32.2
2007	34.2	35.4	34.2	32.1	32.3	30.3	30.2	29.6	29.9	31.2	33.3	32.4
2008	33.3	34.6	34.8	33.2	32.1	31.2	29.2	31.1	30.2	31.4	32.9	33.1

Annual Average Maximum Temperature for Abakaliki for the past 20 years

	Annual average maximum temperature °C											
Yrs	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
T_{max}	32.2	32.3	31.8	31.8	31.9	32.0	32.2	32.2	32.3	32.9	32.3	32.5
Yrs	2001	2002	2003	2004	2005	2006	2007	2008				
T_{max}	32.4	32.5	33.0	32.2	32.7	32.0	34.7	38.4				

Annual Maximum Temperature

The annual maximum temperature is taken from records of daily maximum temperature readings averaged over the month. The month in which the highest readings are recorded is March for Enugu. For the period 1988 - 2008 therefore, the annual maximum temperature = 38.4Deg C for Enugu.

e) Mean Monthly Evaporation (Piche)

Year	Mean monthly Evaporation (Piche)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1988	7.9	7.8	5.8	4.8	3.4	2.7	2.3	2.7	2.1	2.4	3.7	5.2
1989	11	11.7	7	5.7	2.8	2.5	2.1	1.7	2.2	2.4	4.1	6.7
1990	6.4	9.9	5.9	5.3	3.5	2.6	1.8	1.8	1.9	2.5	3.3	3.9
1991	7.1	6.4	5.5	3.1	2.3	2.2	1.8	1.7	2.2	2.5	3.3	7.3
1992	9.6	11.3	5.7	4.2	3.1	2.4	2.1	2.3	2.1	2.7	4.3	6.5
1993	9.7	7	7.3	4.7	3.4	2.8	2.6	1.9	2.3	2.5	3.1	6
1994	7	7.4	7.2	4.6	2.8	2.7	2.2	1.8	2.2	2.3	4.8	9.4
1995	8.9	8.3	6.3	4.5	2.7	2.3	2.1	1.8	2.3	2.2	4.8	5.5
1996	5.6	6.1	5.6	4.4	3.2	2.7	2.3	2.1	2.4	2.7	5.8	5.6
1997	7.3	13	6.4	3	2.8	3.2	2.4	1.9	2.3	2.3	2.8	5.1
1998	8.2	8.1	8.7	4.9	3.2	2.6	2.4	2.6	2.3	2.5	3.9	6.1
1999	6.4	5.5	6.1	4.6	3.1	2.7	2.4	2.5	2.3	2.3	3.4	6.7
2000	9.9	12.7	5.4	3.8	3.7	2.9	2.7	2.5	3.2	3.2	3.5	5.7
2001	8.5	10.2	5.6	4	2.9	2.6	2.4	2.1	2.2	2.8	4.5	6.1
2002	11	8.3	5.8	4.2	3.3	2.5	2.2	2.1	2.2	2.1	3.6	7.5
2003	6.5	7.2	7.1	5.3	4	2.4	2.4	2.4	2.1	2.7	3.5	6.8
2004	7.4	9	8.6	4.5	2.9	2.7	2.4	2.2	2.3	2.7	4	5.6
2005	9.3	6.9	6.2	5.6	3.3	2.7	2.1	2.5	2.2	2.6	3.9	4.8
2006	4.9	5.2	5.8	5.1	2.6	2.5	2.2	2.5	2	2.4	5.2	7.6

f) Average Maximum Relative Humidity

Year	Average Maximum Relative Humidity,%											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1988	52	67	72	72	79	79	82	81	84	82	75	60
1989	26	39	67	72	79	82	84	87	83	82	74	56
1990	65	49	53	73	78	81	86	83	84	81	76	75
1991	55	71	73	80	83	83	86	86	84	80	78	50
1992	42	49	73	78	80	82	84	83	85	82	68	59
1993	42	71	67	76	79	81	83	87	85	82	78	55
1994	60	66	68	76	82	80	85	88	86	83	69	36
1995	42	62	72	75	82	84	85	87	84	82	65	68
1996	74	70	73	77	80	82	85	86	82	80	61	70
1997	64	31	68	81	80	82	81	85	85	82	80	62
1998	43	57	59	75	79	83	81	81	85	83	77	59
1999	64	72	71	74	82	83	86	83	84	83	78	58
2000	65	43	62	75	80	83	84	86	84	83	74	52
2001	50	49	73	77	81	80	83	85	85	81	73	67
2002	36	59	74	77	79	84	85	84	82	84	76	48
2003	61	69	68	74	76	84	82	81	84	80	75	54
2004	51	55	60	74	80	81	81	84	85	81	76	70
2005	42	67	72	71	79	84	87	81	84	81	77	70
2006	75	76	70	75	83	83	84	82	88	85	65	48

g) Average Minimum Relative Humidity

Year	Average Minimum Relative Humidity,%											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1988	33	34	52	56	62	68	72	68	74	67	49	46
1989	21	23	41	52	67	69	72	75	83	65	47	34
1990	38	27	24	53	62	69	75	73	69	65	58	55
1991	47	45	51	63	70	70	74	73	70	66	55	35
1992	29	21	50	61	80	71	73	72	71	66	53	39
1993	31	40	46	59	64	67	70	76	70	66	62	39
1994	41	33	46	58	67	68	74	77	75	70	47	27
1995	30	32	50	58	68	71	74	75	69	71	48	41
1996	44	50	53	61	66	69	71	73	72	65	38	38
1997	39	17	48	66	67	68	69	74	71	70	63	42
1998	31	33	38	58	64	68	72	70	74	68	53	40
1999	41	51	53	59	67	68	70	69	71	69	57	36
2000	39	27	36	55	63	68	71	73	72	66	52	34
2001	25	26	51	59	68	67	70	74	74	64	48	38
2002	25	36	54	62	63	69	72	73	71	70	50	32
2003	38	39	40	56	59	70	69	69	71	65	54	33
2004	35	35	46	58	66	69	72	73	72	67	52	38
2005	30	43	52	53	65	68	76	73	71	65	50	47
2006	49	50	50	52	67	67	73	72	73	66	44	26

h) Annual Average Humidity

Year	Annual Average Humidity, %											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1988	43	51	62	64	71	74	77	75	79	75	62	53
1989	24	31	54	62	73	76	78	81	83	74	61	45
1990	52	38	39	63	70	75	81	78	77	73	67	65
1991	51	58	62	72	77	77	80	80	77	73	67	43
1992	36	35	62	70	80	77	79	78	78	74	61	49
1993	37	56	57	68	72	74	77	82	78	74	70	47
1994	51	50	57	67	75	74	80	83	81	77	58	32
1995	36	47	61	67	75	78	80	81	77	77	57	55
1996	59	60	63	69	73	76	78	80	77	73	50	54
1997	52	24	58	74	74	75	75	80	78	76	72	52
1998	37	45	49	67	72	76	77	76	80	76	65	50
1999	53	62	62	67	75	76	78	76	78	76	68	47
2000	52	35	49	65	72	76	78	80	78	75	63	43
2001	38	38	62	68	75	74	77	80	80	73	61	53
2002	31	48	64	70	71	77	79	79	77	77	63	40
2003	50	54	54	65	68	77	76	75	78	73	65	44
2004	43	45	53	66	73	75	77	78	79	74	64	54
2005	36	55	62	62	72	76	82	77	78	73	64	59
2006	62	63	60	64	75	75	79	77	81	76	55	37

i) Average Dew point Temperature

Year	Average Dew point Temperature, ˚C											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1988	14.3	19.8	23.0	23.1	23.4	23.0	22.2	22.2	22.8	23.1	21.9	16.8
1989	15.4	19.7	20.9	22.4	23.2	22.8	22.6	22.6	22.5	23.0	21.4	15.3
1990	18.1	12.7	14.9	22.9	23.3	22.8	22.8	22.5	22.8	22.9	22.7	21.6
1991	16.3	22.2	22.8	23.4	23.7	23.7	22.9	22.8	22.9	22.4	22.5	13.3
1992	10.4	11.8	22.3	24.0	23.7	23.0	22.5	22.2	22.8	23.0	19.9	17.3
1993	12.0	20.8	20.3	23.2	23.5	23.1	22.6	22.7	23.0	23.3	23.2	15.5
1994	16.5	17.8	22.3	23.3	23.7	23.2	22.8	23.2	23.5	23.4	19.8	10.2
1995	11.4	17.4	22.6	23.6	23.9	23.4	23.1	23.2	23.3	23.3	19.1	18.9
1996	20.9	22.0	23.1	23.6	23.9	23.4	22.6	22.6	22.8	22.7	17.9	19.5
1997	17.8	6.6	20.5	23.5	23.4	12.7	22.6	23.1	23.5	23.9	24.0	18.3
1998	12.9	18.2	18.3	24.4	24.5	23.8	23.2	22.5	23.2	23.9	23.1	17.3
1999	18.1	22.4	23.1	23.3	23.5	23.4	22.8	22.6	22.8	23.1	22.9	16.0
2000	18.7	12.3	18.4	23.0	23.8	23.0	22.8	22.7	23.3	23.3	22.3	15.1
2001	11.8	12.4	22.7	23.4	23.8	23.1	22.6	22.6	22.9	23.2	22.1	19.4
2002	9.5	17.5	23.5	23.8	24.0	23.4	23.5	22.9	22.8	23.3	21.8	13.8
2003	17.4	20.9	21.3	23.4	23.5	23.1	22.8	22.8	23.0	23.5	22.6	14.7
2004	14.8	17.2	20.6	23.6	23.2	22.9	22.7	22.6	22.9	23.4	22.8	21.4
2005	10.7	20.9	23.2	23.1	23.6	23.6	23.3	22.5	23.4	23.2	22.0	20.0
2006	22.2	23.1	22.2	23.4	23.3	23.5	23.3	22.6	23.3	23.6	19.2	21.3