Republic of Senegal

One People – One Goal – One Faith

Ministry of Environment and Sustainable Development (MEDD)

Ministry of Petroleum and Energy (MPE)

Department of Environment and Classified Establishments (DEEC)

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CONSTRUCTION AND OPERATION OF A 120 DUAL-FUEL POWER PLANT PROJECT IN MALICOUNDA, THIES REGION

Final Report

October 2018

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List of acronyms and abbreviations

AfDB	African Development Bank
AFR	Alliance for the Republic
AICPE	Installation Classified for the Environment Protection
ANACIM	National Agency for Civil Aviation and Meteorology
ANAT	National Agency for Spatial Planning
ANSD	National Agency for Statistics and Demography
ART	Article
ASUFOR	Association of Borehole Users
ATEX	Explosive Atmosphere
BARPI	Analysis Office for the Risks and Industrial Pollutants
BNSP	National Brigade for firefighters
BOOT	Build, Own, Operate and Transfer
BTP	Buildings and Public Works
CCOD	Control Commission of Domanial Operations
CDD	Fixed-term Contract
CDM	Clean Development Mechanism
CDREI	Departmental Committee of Census and Disbursements Evaluation
CEDEAO	Economic Community of West African States
CHST	Hygiene, Health and Security Committee
CNULCD	United Nations Convention to Combat Desertification
CR	Recovery Boiler
CRSE	Commission of Regulations of the Electricity Sector
CSR	Corporate Social responsibility
DAO	Tender Document
DEEC	Environment and Classified Facilities Office
DEIE	Environmental Impact Assessment Office
DGCPT	Directorate General of the Public Accountability and Treasury
DGID	General Tax and estate Office
DGP	Directorate General of the Plan
DGPRE	Directorate of the Management and the Planning of Water Resources
DGTSS	Directorate General of Labor and Social Security
DMT	Declaration of Worker's Movements
DPC	Civil Protection Office
DREEC	Regional Environment and Classified Installation Offices
DUA	Directorate of Urbanism and Architecture

ECOWAS	Economic Community of West African States
EDD	Risk Study
EIA	Environmental Impact Study
EP	Equator Principles
EPB	Protection Equipment to combat Noise
ERP	Public Owned Building
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and social Management Plan
GHG	Greenhouse Gas
HFO	Heavy Fuel Oil
HP	High Pressure
HSE	Hygiene, Security, Environment
HT	High Tension
HTA	High Tension
IEA	Initial Environmental Analysis
IFC	International Finance Corporation
ILO	International Labor Organization
INERIS	National Institute of the Industrial Environmental Risks
IOP	Internal Operations Plan
IPRES	Retirement Provident Senegal Institution
IRED	Regional Initiative for Sustainable Energy
IREF	Regional water and forestry inspection office
IRTSS	Regional Inspection of Labor and Social Security
LEC	Leveled Electricity Cost
LFO	Light Fuel Oil
LHV	Lower Heating Value
LPD/SEDD	Letter of Policy Development in the Environment and Sustainable Development
LPDSE	Letter of Policy Development in the Energy Sector
MEDD	Ministry of the Environment and Sustainable Development
MEFP	Ministry of the Economy, Finance and Planning
MP	Average Pressure
MT	Average Temperature
MW	Megawatt
OS	Operational Safeguard
PAN/LCD	National Action Plan to Combat Desertification
PAP	People Affected by the Project

PDC	Plan of Communal Development
PFS	Forestry Policy of Senegal
PLC	Programmable Logic Controller
PM	Particulate Matter
PNAE	National Environment Action Plan
PNAT	National Plan for Spatial Planning
PPI	Personal Protection Equipment
PSE	Senegal Emergent Plan
RDA	Regional Development Agency
RIA	Fire hose reel system
SA	Joint-stock company
SDS	Safety Data Sheet
SENELEC	National Senegal Electricity Company
SME	Small and Medium-sized Enterprises
SOCOCIM	Cement Marketing Company
SONATEL	National Telecommunication Company
STE	State Technical Service
ULSD	Ultra-Low-Sulfur Diesel
WHO	World Health Organization

I. NON-TECHNICAL SUMMARY

I.1. INTRODUCTION

Despite the rising production capacity on the national level and the significant advancements, the energy sector is facing obstacles and challenges of various orders that must be faced. In fact, the part of available energy for each household remains insufficient to promote the socio-economic emergence and development despite SENELECs efforts.

Hence, the introduction and the realization of the project for the construction and operation of the Malicounda thermal power plant were initiated by SENELEC which would allow them to enter into a new era for the energy sector during which the self-sufficiency in energy will become a reality throughout the whole country.

I.2. PROJECT DESCRIPTION

I.2.1. GENERAL PRESENTATION OF THE PROJECT

The project consists of the construction and operation of a 120 MW thermal fuel power plant running on heavy fuel HFO, equipped with seven (07) identical engines and one (01) steam turbine in continuous operation on the site of Malicounda.

The power plant will include seven (07) reciprocating engines running on fuel oil each with an 18 MW capacity. A combined-cycle is also planned, which will allow to have a higher efficiency.

The Malicounda power plant will use heavy fuel oil as fuel and then will switch gas once it becomes available in Senegal (around the year 2021).

The thermal power plant will be built on a land parcel of approximately 06 ha to be distracted from the 18 ha that were already conceded by the municipal council of Malicounda on the 13th of June 2018.

I.2.2. OPERATING PRINCIPE OF A COMBINED CYCLE THERMAL POWER PLANT

The operation of the power plant is carried out according to different steps:

- Unloading, storage and fuel heating;
- Purification, filtration and fuel dispatch towards the engines for combustion;
- Transformation of the mechanical energy into electrical energy in the engines by the generators;
- Cooling and engine components lubrication with respectively, water and new or regenerated Lube oil;
- Engine exhaust gas evacuation towards the stack pipes;
- Electricity production due to the steam driving the turbine connected to an alternator.

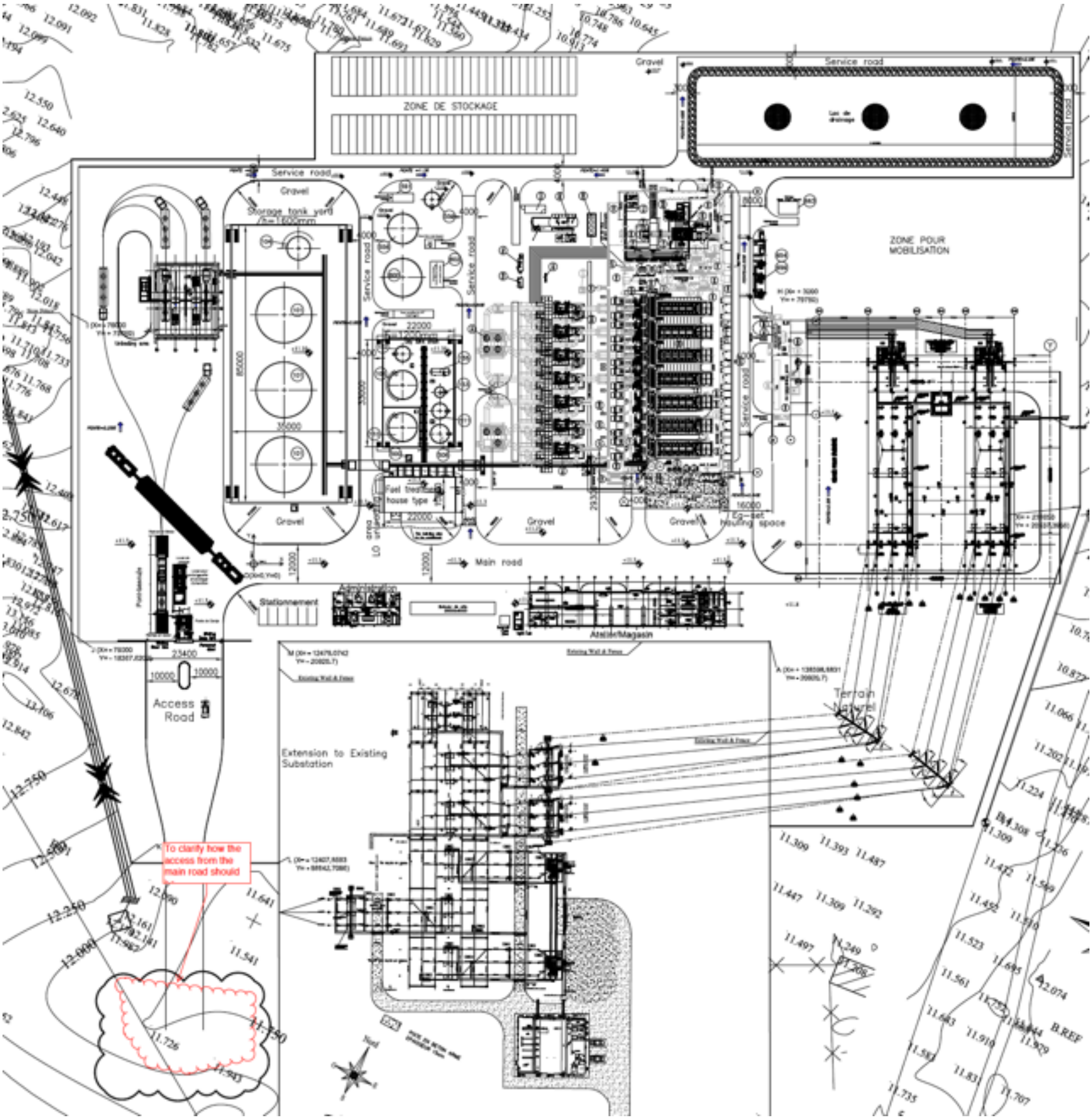


Figure 1 : Lay out of the Power Plant

I.2.3. SUMMARY OF THE MAJOR TECHNICAL COMPONENTS

Table 1 : Main equipment of the Malicounda Power Plant

Units	Components
Electricity production system	07 Wärtsilä generating sets 07 stacks 02 separators 01 auxiliary boiler
Combined-Cycle	01 steam turbine 07 recovery boilers

Units	Components
	02 condensers
Heavy Fuel Oil storage	03 storage tanks : 3000 m3 each 01 daily tank : 560 m3 01 buffer tank : 560 m3
Light fuel oil (Gasoil) storage	01 tank : 200 m3
Lube oil storage	01 new lube oil tank : 75 m3 01 used lube oil tank : 25 m3 01 maintenance lube oil tank : 16 m3
Water storage	01 raw water tank : 500 m3 01 demined water tank : 80 m3 01 firefighting tank : 1 000 m3
Air Storage	07 bottles of compressed cooled air : 0.12 m3
Transformers	02 transformers 90MVA/225/15 kV ONAF
Building and Auxiliary installations	Control room Administrative building Warehouse Mechanical workshop Cafeteria Laboratories Loading/unloading zone Firefighting zone Maintenance workshop Fence

The construction work will be spread over a period of 18 months and the construction of the power plant will require recruitment of about 400 employees while its operation requires 50 employees.

Water supply to the power plant during the construction and the operation will be assured by one (01) borehole.

I.3. Political, Judicial And Institutional Framework

I.3.1. Environmental and Social Management Political Framework

Essential environmental and social political texts of which the content and objectives are applicable to the project on the national and international level are identified in this sub-chapter. We can cite, among other texts, the Senegalese Emergent Plan (PSE), the Letter of Development Policy of the Energy Sector (LPDSE), the Letter of Environment Development and Sustainable Development Policy (LPDEDD) and the United Nations Convention to combat desertification

I.3.2. Environmental and Social Management Judicial Framework

In connection with the context and the project activities, the national judicial framework is marked by many texts that deal with the environmental and social aspects.

Mainly, these are the Constitution of Senegal, the Environment Code and its applied texts as well as the environmental norms (NS 05-061 and NS 05-062).

Other legal texts which concern the environment as well as the natural resources management which may apply to the project are the Water Code, the Hygiene Code, the Sanitation Code, the Labor Code, the Forestry Code and the Urbanism Code. Land, electricity sector and decentralization related texts, must also be taken into account.

On the community level, different energy and environmental sector texts that was adopted, take part in the legal arsenal applicable to the project.

Internationally, the applicable texts are related to the environmental and social procedures of the African Development Bank (AfDB), the World Bank and agreements and conventions ratified by Senegal. These procedures refer to the 10 principles of the Equator ("Equator principles –EP") in its III version of 2016 (EPIII). It consists of a set of provisions made for a healthy environmental and social issues management. By voluntary signing the Equator Principles (EP), the bank engages in taking into account a certain number of environmental and social evaluation criteria when choosing projects that it will fund. We can consider these principles as an application of the CSR in the domain of finance. These AfDB Environmental Norms have not been the subject of a Convention nor a signed agreement with the Senegalese State. Hence, they will be respected by all the clients of the Bank when receiving financing for a project that will affect the site environment. The Integrated Backups System (SSI) is divided into five (05) Operational Safeguards:

- **Operational Safeguard N^0 1:** Environmental and Social Assessment
- **Operational Safeguard N^0 2:** Involuntary Resettlement, land acquisition, population displacement and compensation.
- **Operational Safeguard N^0** 3: Biodiversity, renewable resources and ecosystem services
- **Operational Safeguard N^0** 4: Pollution prevention and control, greenhouse gas, hazardous materials and resource efficiency.
- **Operational Safeguard N^0 5:** Labor conditions, health and safety.

Other norms and relevant guidelines remain applicable once they are launched within the SSI framework. Mainly consisting of:

- Bank Gender Policy (2001);
- Civil Society Engagement Framework (2012);
- Dissemination and Data Access Policy (2012);
- Handbook for Consultation and stakeholders' participation in the Bank activites (2001);
- Bank Policy related to population and implementation strategies (2002);
- Environmental and Social Evaluation Procedures for the Bank activities (2015).

Among the international conventions and agreements, we can mention the Convention on nature protection and wildlife preservation, the African Convention on the conservation of nature and natural resources, Maputo (Mozambique), and the ILO Conventions on safety, hygiene and health.

Table 2 : AfDB Operational Safeguards

AfDB Operational Safeguards (OS)	Application to the Project
OS N^0 1: Environmental and Social Assessment This OS governs the process of environmental and social category determination of the project, and thereunder the environmental and social evaluation conditions.	This Operational Safeguard updates and consolidates the engagement policies outlined in the environmental policy of the Bank. This OS is applicable to the project in whole. The project of the construction of a power plant in Malicounda requires a certain environmental and social evaluation level adapted to the potential risk significance, in a way that allows to the borrower to prepare and implement an ESMP in the case of this investment project. This comprehensive ESIA was defined as class A and confirmed by the Directorate of the Environment and the Classified Establishments (DEEC) of the Ministry of Environment and Sustainable Development of Senegal in its validation letter for the terms of reference of ESIA (addressed to the Quality, Security and Environment Director of SENELEC) n^0 181 of the 15th of January 2018/MEDD/DEEC/DEIE and its annex on the detailed axes of the ESIA expected report.
OS N^{0}2: Involuntary resettlement, land acquisition, population displacement and compensation This OS N^{0}2 consolidates the engagements and political conditions set forth in the AfDB policy on the involuntary resettlement and incorporates a certain number of enhancements willing to increase the operational efficiency of these conditions.	In accordance with the OS 2 of the AfDb Bank, the promoter must ensure a fair and equitable compensation for the PAP who lost their lands with the emergence of the project and the resettlement that enhances their lifestyle and the global livelihood means. In this study, it is highlighted that SENELEC ensures the OS respects and pays the compensations to the concerned persons through the PAR which is in progress. For the PAR preparation of the Malicounda Power Plant, the consultant refers to the documents of this OS 2. The OS 2 constitutes the main reference for the PAR elaboration and has three (03) main objectives: 1. The minimization of the resettlement while studying all the alternatives in the project conception (buffer zone of 260 m circumscribed on the land of 18 ha of the power plant site). 2. When a displacement is inevitable with goods loss, the resettlement activities must be conceived under a program in order to allow the affected persons to benefit from the project. In addition, these persons must be consulted in a way to participate in the planning and the implementation of the resettlement, compensation and livelihood means restoration program.

	3. The affected persons must find a higher or equal lifestyle to the one they had before their displacement.
OS N°3: Biodiversity, renewable resources and ecosystem services The most important objective of this OS is to conserve the biological diversity and to promote the sustainable use of natural resources. Mainly the water resource in respect of the United Nations Convention on the biological diversity. The OS sheds the light on the necessity of "Respect, conserve and maintain [the] knowledge, innovations and practices of the native and local collectivities etc. [and] to protect and foster the use of biological resources according to the cultural traditional practices compatible with the conservation or sustainable use requirements of the natural resources".	The OS 3 guidelines are applied to the project whose promoter has legal, judicial, regulatory and development standards cited in the report of ESIA. Plant species, small mammals and reptiles can be very sensitive towards certain pollutants. Furthermore, a risk of a small fauna drops (small reptiles or rodents) in the open excavations can be noted during the power plant construction works and could lead to the disappearance or the degradation of the vegetation and a temporary micro fauna perturbation. Hence, the site is highly marked by the human presence with the inauspicious cultural practices to the conservation of the natural vegetation. The OS 3 recommends conserving the biological biodiversity and promoting the sustainable use of natural resources. In order to minimize the potential impacts on the fauna and the flora, the enterprise in charge implements written recommendations to the section VIII.3.
OS N°4 : Pollution prevention and control, **Greenhouse gas, hazardous materials and resource efficiency** This OS 4 covers the whole pollutions, waste and hazardous substances effects range for which there are international conventions and special industry complete norms that are applicable by other MBD. It also introduces a vulnerability follow up analysis framework for the greenhouse gas emissions levels and offers a detailed analysis for the possible decrease or compensatory measures.	The OS 4 guidelines are applicable to the project. In fact, the power plant functioning will provoke pollutants and dust emissions (like Sox, NOx, PM10, PM2.5 and CO) and to a lesser extent, volatile organic compounds (VOC) and aromatic polyclinic hydrocarbons (PAH). The concentration in SOx, NOx, PM10, PM2.5 modeled with NUMTECH, respect the threshold values of the Senegalese repositories and the international standards except the second interim target of the WHO 125 µg/m3 is exceeded on a limited area (section VIII.3.1.2.1). It is important to add to these results, that the power plant is conceived to move to the gas by the year 2021. As a result, a chimney altitude of 42 m was considered enough in the frame of this study and allows to respect the regulatory limits and the OS 4. The power plant operator has to limit the waste production (non-hazardous and hazardous) but also recuperate and reuse the waste ecologically according to the OS 4 principles.

	The promoter has to control these GHG emissions according to the signed agreement in Paris in 2015 while observing the respect of the Senegal Engagement to GHG emissions reduction for the Senegal by the year 2035, during the Paris Agreement on the climate in 2015. The main attenuation proposed measures are: • Ensuring a NOx, SO_2 and PM atmospheric emissions follow up on the chimneys and provide particular and molecular filters in the chimneys; • Insure the use of a sulfur-based fuel (less than 2%). As for the water supply, it will be insured by the borehole (6 m3/h). The hydrogeological study done by the operator allowed to ensure the resource availability and the possibility of implementing this borehole without major consequences. However, during the construction and operation works, water will be rationally used according to the OS 3, in order to preserve the resource and not compete people water supply. The main attenuation proposed measures are: • Proceed to the desulfurization of combustion gas and use low-carbon torch NOx; • Create green spaces for the environment protection and the people lifestyle quality, but also promote the CO2 photosynthesis absorption, main greenhouse gas. A management procedure for hazardous substances will be also developed during the operation phase in order to establish manipulation and storage methods, and security work techniques.
OS N°5: Labor conditions, health and safety This OS 5 defines the AfDB requirements towards its borrowers or clients, related to labors work conditions, their rights and protection from mistreatment or abuse.	According to the OS 5, the operator and the enterprises have to elaborate a human resource policy as well as nature procedures, the project size and the labor force size. They must also guarantee to their employees a healthy and secure work environment. In the event of recourse to an expatriate employee, the operator has to abide to the OS 5 of the AfDB and the migrant employees must be treated in conformity with the local laws and benefit from the same work conditions as the non-migrant employees doing the same work. The promoter provides an internal human resources management policy outlined in the section VII.8.2 and according to the in force Labor Code and the OS 5 requirements. It will focus on the following aspects:

	• The prerequisites before the startup of any activity (enterprise establishment declaration and labors movements records declaration and IRTSS contracts types records; • Human resources policy and procedures with an internal reregulation valid by the labor inspector (schedule, behavior, security measures), communicated and accessible to all the enterprises employees; • Work conditions (respect of the collective conventions of electricity, work conditions enhancement through the hygiene, health and security respect); • Terms of employment and chance equal opportunities and sex. This human resource management policy, proposed to the project enterprise in the ESIA framework must be necessarily communicated and understood by the staff and people.

I.3.3. Institutional Framework

The environmental and social management of this project implies many institutions, national, regional and local structures.

The different identified institutions and structures in the framework of the project are:

- Ministry of Petroleum and Energy (MPE);
- Directorate of Electricity (DE);
- SENELEC;
- Commission of Regulation of the Electricity Sector (CRSE);
- Ministry of the Economy, Finance and Planning (MEFP);
- Directorate of the Environment and Classified Establishments (DEEC);
- Directorate of Urbanism and Architecture (DUA);
- Directorate General of Labor and Social Security (DGTSS);
- Regional Agency for Development (ARD);
- National Agency for Land Displacement (ANAT);
- Control Commission of state land Operations (CCOD).

I.4. Description of Initial Environment

I.4.1. Geographical, administrative situation and localization of the power plant site

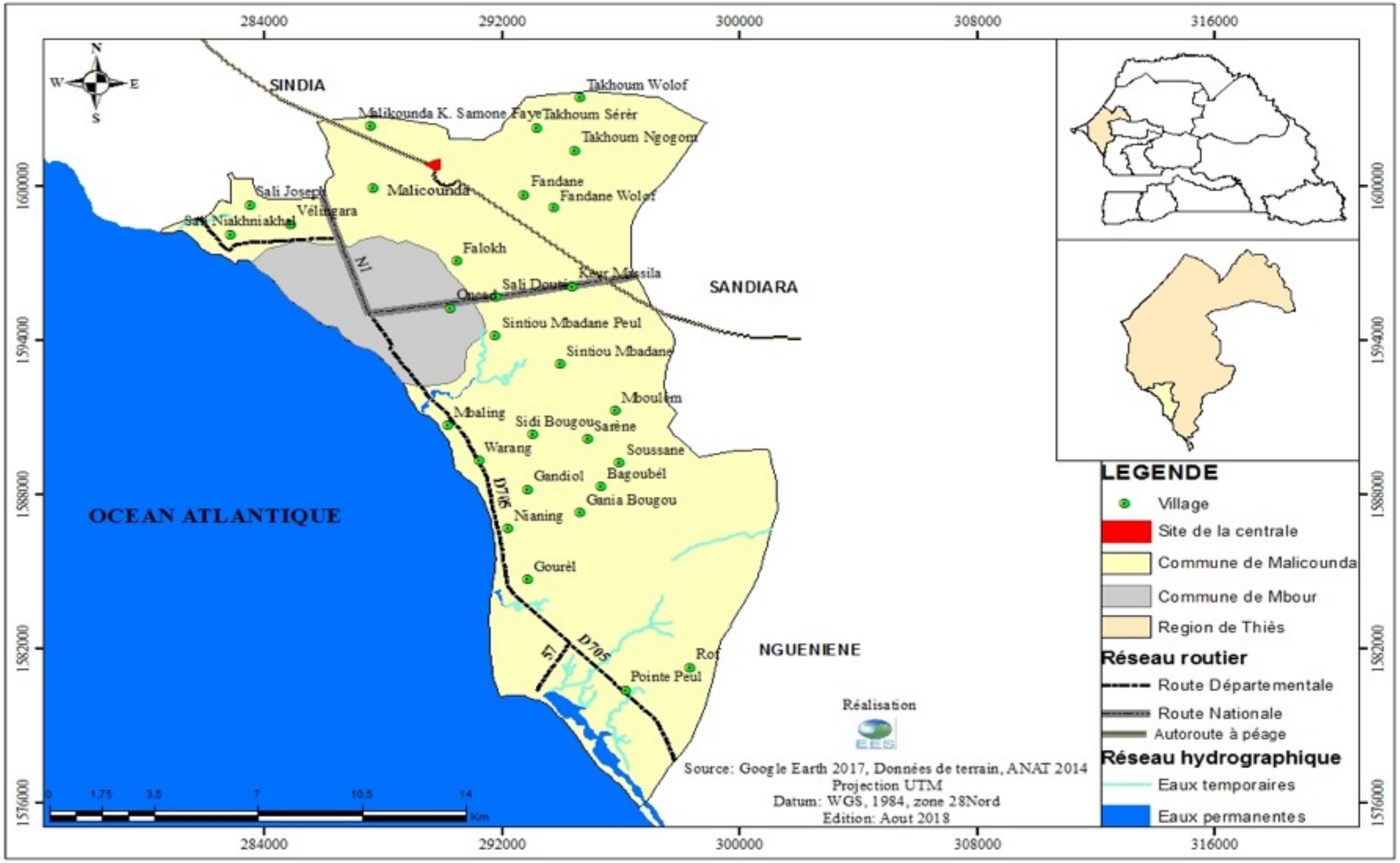
The intended site for the construction and operation of the thermal power plant located in the Malicounda commune, Mbour Department, Thies Region.

The power plant will be implemented in Keur Maissa Faye village (Malicounda Wolof), Malicounda commune, situated south-west of Thies Region, this commune covers an area of 124 km2 and counts 22 villages. It also possesses a coastline on the Senegalese littoral.

I.4.2. Localization of the Power Plant Site

The power plant site is situated to the west of Keur Maissa Faye village, north (about 55m) of the road linking the national road N1 at Malicounda. The site is limited:

- To the north, by rainfed agriculture fields and few buildings under construction;
- To the east, by Keur Maissa Faye street (Malicounda Wolof), an orchard and rainfed agricultural fields;
- To the west, by the national tolling road and by rainfed agricultural fields
- To the south, by the toll highway and rainfed agriculture fields.



Map 1 : Localization of the Power Plant Site

Legend: Village/Site of the power plant/Commune of Malicounda/Commune of Mbour/Region of Thiès/Road network/ Secondary road/Highway/Toll road/Hydrographic network/Temporary waters/ Permanent waters

I.4.3. LAND LOCALIZATION AND OCCUPATION OF INFLUENCES REGIONS

The area of influence corresponds to the space where the potential incidences (dust, noise, discharge in the natural places, etc.) of a project can be noticeable. It depends on the project type and the natural places (fauna habitats, flora, etc.) and surrounding humans.

Concerning the site grasp, this area covers the 18 ha already deliberated by the municipal council of Malicounda on the 13rd of June 2018 in favor of SENELEC envisioning the construction and operation of the thermal power plant on approximately 06 ha.

This area is actually characterized by agriculture lands. In fact, the site is used by the local population who are practicing rainfall agriculture with as dominant speculations peanuts, millet and cow peas.

The table below summarizes the different identified entities in the immediate environment of the site.

Table 3 : Immediate surrounding of the site

Entities	Distance according to the site border	Distance according to the future power plant border	Orientation according to the power plant
Building under construction	Passed by the power plant border	82 m	North
Building under construction	82 m	241 m	
Graveyard	100 m	170 m	
Malicounda Ngueurigne	256 m	362 m	
Verger	14 m	40 m	East
Houses (K. Maissa Faye)	40 m	150 m	
Building under construction	18 m	115 m	
Toll highway	40 m	118 m	West
Life base Ageroute	124 m	219 m	
henhouse	148 m	219 m	
Paved road	55 m	233 m	South
Subdivision	20 m	195 m	
Houses (K. Maissa Faye)	39 m	164 m	

I.4.4. DESCRIPTION PF PHYSICAL ENVIRONMENT

Situated on the Senegalese littoral bordering, the commune of Malicounda, implantation area of the power plant, is situated in the North-Sudanese coastal climatic domain.

Overall, the relief of the welcoming area of the project is relatively flat. At the power plant site, the altitudes range between 10 and 15 m.

The table below represents the major characteristics of Malicounda commune.

Table 4 : Major characteristics of the Commune of Malicounda

Characteristics	Average / Normal Value
Wind speed	2.7 m/s
Temperature	27.3 ^{O} C
Insolation	242 h/month

Rainfall	610.7 mm

I.4.5. Description of the Biological Environment

The study of the biological environment includes the description of the initial state of the fauna and flora but focuses on performing the analysis of eventual impacts of the installation of the thermal power plant on the natural environment.

The area that must host the Malicounda power plant is situated is the Sudanese domain which is by excellence that of savannah under different physiognomies. In fact, the vegetation of the project area is wooded and shrubby savannah type with an herbaceous carpet that dries out generally from the month of November. The faunal potential is less important in the project area mainly because of the pressure exerted by the humans on the faunal habitats.

The essential of the area species is concentrated in the Bandia reserve situated at approximately 09 km from the power plant and the Classified Forests (CF) of the area being that of Balabougou and Nianning, situated respectively at 15 and 16 km from the power plant.

I.4.6. Description of the Human Environment

Malicounda Commune covers an area of 124 km² for an estimated population at 69 932 habitants in 2018. (Projection ANSD 2015)

At Malicounda, the cultural diversity is promoted by the presence of different ethnic communities mostly composed of wolofs, sereers and bambaras. Moreover, these ethnics mainly Muslim are concentrated in the respective villages holding the name of the dominant community (Malicounda Wolof, Malicounda Sereer and Malicounda Bambara).

The drinking water supply of the area is mediocre due to the fact of the discrepancy of the coverage of the four (04) boreholes managed by ASUFOR. In addition, the electricity of the Commune of Malicounda is managed by the Senegalese Agency for Rural Electrification (ASER) through the Tunisian society.

The main activities of the commune are:

- Agriculture
- Fishing
- Livestock
- Aviculture

Therefore, concerning the last activity, none of the three (03) identified farms is situated in the direct area of influence, namely the envisioned 18 ha.

I.5. Analysis of the variants

The analysis of the variants is an ESIA chapter that allows the comparisons among different options of the project in order to propose the best possible alternative on the technological plan with an acceptable cost and a minimum of possible negative impacts.

The different studied alternatives are based on:

- The “no project” option

- The displacement variants
- The water supply
- The site access
- The techniques of energy production

N**o Project option**

The non-realization of the project allows to avoid the potential negative impacts linked to the construction and the operation of the power plant (agricultural land loss, waste generation, noise pollution, etc.).

However, it will be in disagreement with the energetic policy of the country which consists in insuring the energy supply of the country in sufficient quantity and expanding people's access to the modern energy services.

In addition, the non-realization of the project is considered an opportunity loss for the enhancement of people standard of living through the creation of job vacancies, the increase of the commune incomes, the business opportunities for the SME/SMI, etc. On the basis of this analysis, the Malicounda thermal power plant project, despite the negative potential environmental and social impacts, is a necessity to allow the optimization of the energy production means.

Displacement Variants

Concerning the location choice of the different installations of the power plant on the site grip land, many options were analyzed taking into account certain parameters and environmental and security criteria. The three studied variants of positioning, the option 2 was the selected one (final version visible on the layout presented in the annex) because it is considered as the best location according to the installations and in an exhibition to the eventual effects of certain impacts. This choice allows to circumscribe the buffer zone of 260 m in the grip of 18 ha deliberated for the realization of the project. Besides, it will not require a relocation of the habitations nearby the site.

Water supply variants

The water consumption of the project during its different phases constitute a major challenge from the environmental and socio-economic point of view. Thus, two (02) water supply variants were studied, namely:

- The supply from ASUFOR;
- The supply from a borehole put in place by the power plant operator.

From these two alternatives, the selected one is the borehole construction because it allows the insurance of power plant's water autonomy and the avoidance of the competition with the people's water consumption (ASUFOR).

Site access variants

One of the proposed alternatives in this section is the restoration of the paved road leading to the site (since the RN1 to the power plant site) given its advanced deterioration state.
The other studied alternative is the construction of a new access road to the site in the construction phase. In the operation phase, the trucks and the service vehicles that have to drive the site will take the troll highway which is actually under construction.
From these two alternatives, the construction of a new access road was selected. In fact, this option will permit health and security preservation although it requires the acquisition of a new land.

Technical Variants of energy production

The different studied techniques of energy production are:

- Diesel classic plant running on HFO;
- Steam plant running on coal;
- Diesel plant running on gas.

Comparison criteria on the environmental, economic, operational, health and security plan were used to classify the different alternatives in order to identify the most optimal.

Following this analysis, it is shown that the best option is the classic plant running on HFO due to its fuel supply easiness and the low sanitary risk compared to the coal plant if however, the pollutants emissions remain within the acceptable norms.

I.6. PUBLIC CONSULTATIONS

In this section, all the consulted stakeholders have expressed their satisfaction concerning the cabinet process that realizing the present study to the meeting of the stakeholders in order to inform them and gather their opinion.

In the spirit of a good consultation planning, the EES cabinet has elaborated and followed a communication plan that has as an objective the good documentation of the preparatory phase of the public consultation.

It consists in identifying the concerned actors, the characteristics and the specific sensitivities of different localities that will be affected by the project. The institutions and resources-persons to meet target were constrained to the sites and potential PAP as well as members of the environmental and social impacts monitoring process structures.

Therefore, the Technical Committee members will have an important role in the validation of this environmental and social impact study.

After the identification of the actors, the EES cabinet has addressed to each structure, which its implication has been judged relevant, a prior information letter.
Regarding the populations, the socio-economists of the study have done in situ displacements in order to hold a first meeting with the resources-persons designated by the communities.

These consultations permit a big portion of the Project appropriation-acceptance with all the actors. They will allow to take into consideration the environmental and social dimensions of the project and all the actors' categories sensitivities representing human implications (houses and/or economic activities), local representatives and local authorities (administrative and technical services of the State) of the host area.

Different methods were carried out to attain the objectives assigned to the public consultation:

- Individual meetings were privileged during the reunions with the administrative authorities, technical services of the State and the local collectivities concerned by the construction and operation of the Malicounda power plant project;
- Focus-groups organized for the populations, street associations. For these categories of stakeholders, there was an open discussion and everyone could express his opinion by expressing his concerns, expectations and project recommendations.

In all case, the meeting with different actors were held in this way:

- Project presentation;
- Environmental evaluation objectives and the necessity of actively involving the stakeholders in the steps of the evaluation process;
- Questions, opinions, concerns and recommendations gathering.

The below table provides information about the public consultations realization planning.

Table 5 : Consultation Plan with the administrative and municipal authorities

Area	Structure	Place	Date (DD/MM/YYYY)	Number of attending persons
Thies Region	Thies Governance	Governance	11/07/2017	01
	Thies ARD	Thies ARD	11/07/2017	01
Mbour Department	Mbour Prefect	Prefecture	12/07/2017	01
	Sindia subprefect	S/prefecture	14/07/2017	
	Mbour departmental council	Mbour	13/07/2017	01
Malicounda Commune	Municipal Council	Malicounda	12/07/2017	01
Total of administrative and municipal authorities				06

Table 6 : Consultation plan of the technical services of the state on the national and regional levels

Structure	Place	Date (DD/MM/YYYY)	Number of attending persons
National level			
Ageroute	Point E Dakar	10/07/2017	02
Regulation Commission of the electricity sector	Dakar	12/07/2017	01
African Refining Association	Mbao Dakar	14/07/2017	05
Division of the Environmental Impacts Evaluation	Directorate of the Environment and Classified Establishments, Carnot Dakar Street	31/07/2017	01
Division of Pollutants and Noise Prevention and control		31/07/2017	01
Air Quality Management Center		26/07/2017	01
Directorate of the water resources Management and Planning	Camp Lat Dior Dakar	31/07/2017	01
Directorate of the Civil Protection	Dakar	14/01/2017	01
Directorate of the Electricity	Petersen Dakar	14/01/2017	01
Total of the national technical services			14
Departmental and Regional level			

Regional Inspection for Labor and Social Security	IRTSS Thies	13/07/2017	01
Regional Division of the Environment and Classified Establishments of Thies	DREEC Thies	11/07/2017	01
Regional Service of Spatial Planning	Thies spatial planning	11/07/2017	01
Regional Service of Sanitation	Thies Sanitation	11/07/2017	01
Regional Service of Mines and Geology	Thies mines and geology	12/07/2017	01
Departmental Service of Urbanism	Mbour Urbanism	12/07/2017	01
Regional Division of Hydraulic	Hydraulic Thies	19/07/2017	01
Thies Regional Agency of Development	ARD Thies	11/07/2017	01
Thies Regional Service of Statistics and Demography	SRSD/ANSD Thies	14/07/2017	01
Mbour Cadaster Office	Mbour cadaster	12/07/2017	01
Mbour Hygiene Brigade	Mbour hygiene service	12/07/2017	01
Mbour Firefighters	E-mail exchange	17/07/2017	01
Total of the technical services consultations on the regional and departmental levels			**12**

Table 7 : Consultation plan with the beneficiary persons

<table>
<tr><th>Village</th><th>Date
(DD/MM/YYYY)</th><th>Number of attending persons</th></tr>
<tr><td rowspan="4">Malicounda Wolof

Malicounda Serere

Malicounda Bambara</td><td rowspan="3">10/07/2017</td><td>28</td></tr>
<tr><td>51</td></tr>
<tr><td>19</td></tr>
<tr><td>23/07/2018</td><td>100</td></tr>
<tr><td colspan="2">Number of consulted persons</td><td>198</td></tr>
</table>

The consultations have taken place on the 10th of July 2017 and the 23rd of July 2018. They have permitted to consult 230 stakeholders distributed as follows:

- Municipal and administrative authorities: 06
- Technical service on the national level: 14
- Technical service on the regional and departmental levels: 12
- Consulted population in the three (03) villages surrounding the site: 198

A relatively good acceptance of this project that will enforce the energetic tissue of the country appeared after the different meetings.

Therefore, the question linked to the land title appeared many times and was asked by all the stakeholders (administrative authorities, local people) and this shows to what extent it is an important concern and its resolution is unavoidable for the success of the project.

The safety and the atmospheric pollutant emissions linked to the power plant operations were also present in the questions. The relative recommendation is to respect the relative regulation.

I.7. Results of the analysis of the environmental and social impacts

The major impacts related to the project during the construction and the operation phases of the Malicounda thermal power plant were identified and management measures were proposed for each environment component (physical, biological, human) affected by the project in order to mitigate or improve.

Table 8 : Enhancement measures of positive impacts

Component	Impact source activities	Potential Impact	Enhancement Measures
Enhancement impacts during the construction phase			
Socio-economic activities	**Pre-construction and construction activities**	Direct jobs creation	● Implement the Regional Inspection of Labor and Social Security (IRTSS) for the employees' identification ● Prioritize the PAP recruitment ● Promote the local populations mainly the persons with low wages to the non-qualified employments (local labor-force, cleaning, guarding, etc.) and promote their continuous training ● Create a local recruitment committee
		Development of new economic activities	● Arrange and secure spaces that host the new activities (small commerce, restoration, etc.) ● Promote the development of these activities
		Business Opportunities for the SME/SMI	● Develop the subcontracting in order that the small local enterprises acquire market shares and experience
Enhancements Impacts during the operation phase			
Socio-economic activities	**Power plant Operation**	Jobs Creation Goods and services purchase	● Involve the local collectivity in the procedures of recruitment ● Promote the local employment if the profiles are available and insure the continuous training of employees ● Promote the respect of the national labor and employment rights
		Reinforcement of the energetic sector	● Densify the electrical distribution network in the commune ● Study the cost reduction possibilities linked to the Malicounda Commune electricity
		Increase of the commune incomes	● Insure the payment of the Local Economic Contribution (CEL) and the Added and Local Value (VAL)

Table 9 : Mitigation plan of the major negative impacts of the projects

Affected components	Impact source activities	Potential Impact	Mitigation Measure
Impacts mitigation during the construction phase			
Air Quality	Pre-construction and construction works	Alteration of the air quality: • Dust through the use of vehicles and field engines • Atmospheric pollutants emissions	• Irrigate or pulverize the field soil and the circulation roads in order to minimize the dust generation • Recover the field material transportation trucks with tarps • Reduce to the minimum the construction material assembling operations on the transshipment places • Restrict the speed of trucks to 30 km/h to the right of houses and on field • Stop the unused vehicles and engines by avoiding the standby position like a slow-motion engine • Insure a preventative and curative maintenance of the exhaust gas transmitter equipment • Ensure that the vehicles and engines make a full-scale technical visit • Define the technical specifications for the field engines according to the national and international norms in terms of exhaust gas • Inform and raise the awareness of the labors and the coastline populations on the field activities and the HSE procedures (activity planning, circulation plan, risks associated to the field activities, etc.)
Soils, surface and underground waters	Pre-construction and construction works	• Local topography and land restructuring modification • Waterproofing, compaction and settlement • Soil, surface and underground waters pollution:	• Define the heavy vehicles itineraries (work roads) and the work areas in a way that limits the rolling and compaction surfaces • Return the premises in state after the works • Collect the solid and light wastes according to an efficient waste management • Raise the staff awareness concerning waste management to avoid every form of pollution
Water resources used by the populations	Pre-construction and construction works	• Water consumption at the cost of the local populations consumption	• Put in place a draining network to ensure the rainfall water run-off towards the natural circuit flow • Get closer to the DGPRE and the Regional Division of Hydraulic to obtain the required approvals to set up a borehole

Affected components	Impact source activities	Potential Impact	Mitigation Measure
			● Raise the employee awareness on the water importance and the necessity of water reservation and water wasting avoidance
Fauna and flora	Site preparation works	● Loss of vegetation ● Loss of the protected species (e.g.: baobab) ● Fauna habitats deterioration ● Perturbation of the fauna	● Limit the field grip strictly to the necessary surface ● respect the administrative procedure before any action on the flora ● contact the IREF to get a technical opinion ● Set up a reforestation plan and ensure the follow-up in collaboration with the Mbour forest sector. ● Avoid the accidental or voluntary introduction of exotic species and allogeneic species presenting a high risk of invasive behavior. ● Avoid impacts on the habitats situated outside the perimeter by delimiting the work and circulation areas (mark-up the field)
Living environment	Preparatory and construction works	● Living environment pollution and disturbance ● Various waste production and field imputable emissions (noise emissions, dust and smokes, liquids discharge, and packaging, etc.)	● Respect the limit of 85 dB (A) at 1 m for the equipment and used tools ● Perform the works that make noise over the break hours ● collect, sort and route the wastes towards the authorized dischargements ● organize the hazardous waste management (oil, diluents, emptying oils, etc.) and ensure the recuperation and the treatment by specialized enterprises proceeding to regular emptying of septic pits by a registered organism
	Pre-construction and construction works Equipment and material transportation	● Traffic disturbance following the trucks rotation for the excavation works, construction material transportation between unloading areas and the site ● Accidents risks	● Develop a periodic circulation plan for the material and equipment delivery and put indicator billboards for the most dangerous places ● Plan the arrival of heavy equipment ● Use a professional escort between Dakar and the site ● Inform the stakeholders (communes, populations, etc.) of the convoy date (through the radio, newspapers) on the itineraries, the risks and measures to be taken to avoid accidents
Allocation and land use	Site release	● Lands loss ● Production loss ● Wages loss	● Comply with the OS 2 and the AfDB requirements for the involuntary displacements of economic activities ● Create a census and evaluation commission for the disbursements composed by the technical services of the State (STE), SENELEC representatives, PAP and the Sub-prefect of SINDIA

Affected components	Impact source activities	Potential Impact	Mitigation Measure
			● Identify and compensate the producers and the cells tenderers in the PAR framework ● Provide the restoration of livelihood means for the PAP in the PAR
Cultural heritage	Pre-construction and construction works	Cement industries impacts	● Close the graveyard once the works start ● Inform the concerned authorities in case of archaeological remains during the works ● Raise the employees awareness on their behavior in case of archeological remains ;
Hygiene, health and security	Pre-construction and construction works	● Respiratory or dermal diseases development ● Insalubrity following the anarchic waste discharge ● Injury risks	● Put at the disposal of the employees the hygienic and adequate toilets ● Set up an HSE team to ensure the protection and the prevention of professional and environmental risks ● Provide adapted EPI for the employees and ensure that they put them ● Establish a plan and circulation rules in the field ● Put danger pictograms, protection tags and ban billboards and signaling in all the danger places ● Make information and awareness campaigns about the populations behavior
Impacts mitigation during the operation phase			
Air Quality climate	● Equipment functioning ● Heavy fuel combustion ● Operation activities	● Air quality alteration	● Ensure a NOx, SOx and PM atmospheric emissions monitoring on the chimneys and target points levels ● ensure the use of a good quality gasoline ● create green spaces ● Make reforestation campaigns
Soil, surface and underground waters	● Fuel manipulation (transportation, unloading, storage, etc.) ● Oil use and storage	● Soil pollution ● Runoff and underground water contamination	● Set up a rainfall water management plan ● Use the retention cuvettes or containment basins for the chemical products storage ● set up intervention procedures in case of an accidental spill or leak ● sort then recycle and storage the waste in a sealed storage area ● Make a regular follow-up for the solid and liquid waste that might be pollutants

Affected components	Impact source activities	Potential Impact	Mitigation Measure
	• Power plant maintenance and cleaning		• find the approved sectors for the transportation, storage and waste elimination
Water resources used by the populations	Power plant water supply	• Water excessive consumption on the cost of the local population consumption • Resource pressure	• Set up a water rational management policy • Repair on time every deterioration that causes a water leakage • Set up a piezometer with an automatic data recorder for a better monitoring
Fauna and flora	• power plant operation activities • noise and waste generation	• Fauna disturbance • Annoyance of the fauna mainly the avian	• Avoid the proliferation of exotic species in rapid growth • ensure the noise reduction caused by the engines through regular technical visits • create green spaces in the power plant • Make reforestation campaigns
Living environment	Power plant operation activities	• Sound pollution • Waste generation	• Ensure the strict application of the waste management plan • Opt for an oil valorization, used grease and centrifugation slurry in a cement industry like SOCOCIM • Equip and request to the employees the anti-noise helmet • Make acoustic measurements in property limit if the maximum noise limits were not surpassed

Affected components	Impact source activities	Potential Impact	Mitigation Measure
Hygiene, health and security	● Power plant startup ● Organizational, technical or mechanical failures ● Gasoline transportation and storage	● Respiratory affections ● Fires ● Injury risks ● Insalubrity following the anarchic waste management ● Circulation accidents	● Set up a POI ● Establish an HSE committee and designate a person in charge ● Provide Data and security Sheets (DSS) to the concerned employees ● Put signals indicating the danger's type and the prohibitions in all requiring places ● Identify ATEX areas and set up security advice ● Set up security showers and ocular showers near the dangerous products areas ● Make the regular inspections and the preventative maintenance of the installations and equipment (storage tubs, retentions, etc.) ● ensure the tanks truck drivers habilitation; ● raise the awareness among the populations on the precautions to be taken during combustible transportation

I.8. RISK ASSESSMENT

The risks assessment has revealed the presence of risks that might affect the physical integrity of employees and the surrounding populations. According to the initial risks and the accidental scenarios, domino effects are likely inside and outside the site. The major accident scenario identifies the trigger of a classic boil-over.

In using upper-bound distance hypothesis, the effect distances caused by a classic boil-over of a heavy fuel exceeds the site borders. The targets that are likely to get affected are the orchards and the cultivation lands situated in the site surroundings and the unmanaged lands. This phenomenon of boil-over was also modeled by INERIS for this project.

The modelling of such a phenomenon consequences and the determination of different intermediate magnitudes, according to the methodology described in the INERIS Ω13 report, were realized on the basis of a storage container of 16m diameters and 16m of height until a diameter of 14 m of liquid, during the fire outbreak.

The outbreak time is estimated at two (02) days and three (03) hours. The maximal ray of the fire ball is 148m. The irreversible, lethal and non-lethal effects distances are respectively 260, 351 and 440 m.

In the case of a fix roof bin like the project case, a phenomenon leading to the roof disappearance and a fire will outbreak an internal explosion for example, knowing that it will not lead to the roof opening. The fire will last long before the phenomenon occurrence, two (02) days and three (03) hours.

Regarding the protection means, for the concerned installation, the first security measure is a drain system to evacuate continuously the water. **In the absence of water, the boil-over phenomenon is impossible**. It is important to mention that, for the phenomenon occurrence, water must be shaped, a continuous sheet. For the roof of concave and convex types, the necessary water quantity for the boil-over outbreak as calculated is relatively important. Therefore, the occurrence probability of the phenomenon will be significantly reduced in the case of a concave roof.

The second important measure is the organizational nature with POI and the implementation, in case of fire, an anti-fire extinction system.

These measures allow to reduce the occurrence probability of the boil-over phenomenon.

It is necessary to mention that:

- The annual occurrence probability of the phenomenon is extremely low (of 10^{-5} or 10^{-6} even less);
- The kinetic of the phenomenon is slow and in this way it allows the mobilization of agents and relief means and when needed, the setup of protection means for the populations during the fire.

The power plant that extends over about six (06) ha is situated inside an 18 ha site. An efficient application of prevention, intervention and protection measures can reduce the security distance of 260 m maximum, corresponding to the distance of irreversible effects.

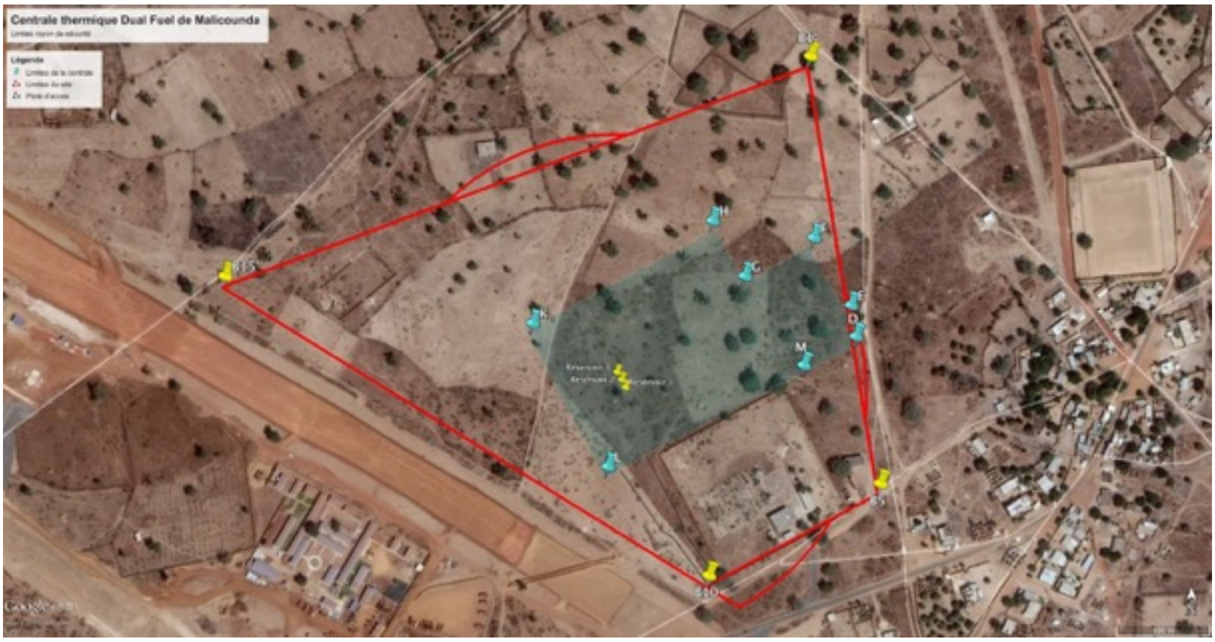


Image Google Earth 1 : Limit of the site requiring a RAP following the risk assessment

I.9. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The Environmental and Social Management Plan (ESMP) aims at ensuring the correct realization and the set deadlines, of all the negative impacts mitigation measures and the enhancement of positive impacts.

I.9.1. ENVIRONMENTAL SURVEILLANCE AND MONITORING PLAN

I.9.1.1. ENVIRONMENTAL SURVEILLANCE

The environmental surveillance is the operation that allows the application of elaborated mitigation measures (ESMP) and the respect of law and regulations in terms of the environment. The environmental surveillance is under the responsibility of the project company (SENELEC and Malicounda Power).

Table 10 : Recap of surveillance measures

Concerned components	Recommended measures	Period	Cost[1] in CFA F	Person in charge
Air quality	Make noise and dust measures in the field	During the works	6 000 000 (Equipment acquisition)	MP
	Set up speed restrictions on the road access from the start of the construction phase	Before the works	For the record	Enterprise in charge of works
	Establish a monitoring on each chimney during the whole operation phase	Operation phase once per month	6 500 000 (Equipment acquisition)	MP

[1] This cost is indicative and serves as the basis to know the expenditures to be made in the social and environmental management framework.

Concerned components	Recommended measures	Period	Cost[1] in CFA F	Person in charge
	Make continuous measures of the ambient air quality (SO_2, NO_X) for 10 points on the site surroundings via passive tubes	Construction phase (monthly)	4 500 000 per year	MP
	Make measures for the ambient air quality (SOx, NOx, CO, PM, COV) for a minimum 10 points on the site surroundings before the start of the construction phase	Operation phase (once per month)	5 000 000	MP
Noise	Make measures for the ambient noise level before the start of works	Quarterly Operation phase	For the record	MP
	Make surveillance for the noise level in work area	Quarterly operation phase	For the record	MP
Surface and underground waters	Set up a piezometer with an automatic data recorder for the groundwater follow-up	Construction phase	For the record	MP
	Provide from the beginning of the works, drain channels for the rainfall and used waters	Construction phase	For the record	MP
	Conduct hydrogeological studies to confirm the water availability (necessary for the drill)	Before the works	For the record	MP
Fauna and Flora	Apply the convention between SENELEC and the Waters and Forests on the land taxes to obtain the tree cutting permit	Before the works	For the record	SENELEC/MP
	Set up a green belt all around the power plant borders (Convention with the waters and forest service)	construction Phase	For the record	SENELEC/MP
Living environment	Set up an engagement plan for the stakeholders before the construction phase	Before the works and during the construction and operation phases	Cost included in the operation budget	SENELEC/MP
	Set up a grievance regulations mechanism	Before the works	Cost included in the operation budget	SENELEC/MP
	Communicate with the commune on the convention concerning the non-hazardous waste collection and elimination	Before the works	For the record	MP
	Contract with a registered provider for the hazardous waste collection and elimination	Operation phase	For the record	MP

Concerned components	Recommended measures	Period	Cost[1] in CFA F	Person in charge
Socio-economic impacts	Set up a local recruitment commission to promote the local employment (taking charge the organization and logistic commission fees)	Before the works	200 000 by session (with in average 5 sessions per year)	MP / SENELEC / local Authorities
	Set up a resettlement action plan (RAP) for PAP	Before the works	40 000 000	SENELEC / CDREI
	Execute the RAP	Before the works	To evaluate in the RAP	SENELEC / CDREI
Environmental and social management	Set up an internal HSE management system with a dedicated team	Operation phase	Cost included in the operation	MP
	Set up an HSE team for the work supervision and the implementation of engagement stakeholders plans and grievances regulations mechanisms	Operation phase	Cost included in the operation	MP
	Make a reinforcement of the DEEC capacities with thermal power plant environmental and social management trainings (See paragraphs X.5.2 and X.6)	Operation phase	20 000 000 (unique subvention)	MP
	Provide an annual budget for the surveillance and environmental and social monitoring committee functioning, managed by the DEEC (see paragraphs X.5.2 and X.6)	construction and operation phases	3 000 000 (construction phase) 1 500 000 per year (operation phase)	MP

I.9.1.2. ENVIRONMENTAL MONITORING

The environmental monitoring is the time and space control of proposed mitigation measures. In fact, it describes the selected measures by the ESMP in order to verify, on the field, the evaluation accuracy of certain impacts and the efficiency of certain mitigation or compensation measures.

The monitoring is ensured by the State authorities with the DEEC and concerned technical services.

The monitoring committee budget is estimated at 20 000 000 FCAF for the reinforcements of the capacities, in addition to the annual budget related to the committee's functioning during the construction and operation phases.

Table 11 : Elements of the environmental monitoring

Aspect	Monitoring Type and place	Method / Indicators to follow	Periodicity	Date of implementation
PAP Livelihood means	Monitoring the PAP on the local populations level	Elaboration of the livelihood means restitution plan and PAP support measures	To be determined in the PAR	Before the works
Air quality emissions	NOx, SO_2, CO, O_2 concentration measures on the stacks level	By a registered enterprise handheld analyzer; Deviation between the measures results and the VLE of the norm NS 05-062; Corrective measures modifications.	Annually	Since the power plant implementation
Air quality emissions	NOx, SO_2 concentration measures in the ambient air surrounding the power plant, in the property limits and in function of the wind dominants	Concentration measures by dissemination tubes; Deviation between the measures results and the VLE of the norm NS 05-062; Corrective measures modifications.	The whole six (06) months, in collaboration with CGQA laboratory	Before the implementation and during the operation
Used rejected waters quality	Sampling on the discharge points level	Parameters measures of used waters of the power plant (pH, MEST, DBO_5, DCO, total azote, total Phosphor, total hydrocarbons, etc.); Deviation between the measures results and the VLE of the norm NS 05-061.	The whole six (06) months	Since the beginning of the implementation
Underground waters quality	Sampling starting from the power plant borehole and the piezometer with automatic data recorder	Periodic analysis of the water physio-chemicals characteristics; Deviation according to the potability norm.	The whole six (06) months	From the implementation date
Water consumption	Counters and flowmeters pose on the drilling pump level	Aquifer productivity control and behavior evaluation of the groundwater level; Overconsumptions control.	The whole months in collaboration with DGPRE	From the implementation date
Noise	Acoustic power level of the power plant equipment (diesel engines, turbo-compressors, air compressors, etc.)	Realization of the noise measures by a sonometer integrator class 1; Noise cartography; Number of anti-noise installed device.	The whole six (06) months	Since the power plant implementation
	Sound level in the power plant property limits	Realization of the noise measures by a sonometer integrator class 1; Noise cartography; Number of anti-noise installed device.	The whole six (06) months	At the beginning of the operation phase

II. INTRODUCTION

II.1. Study Context

Senegal has known an energy crisis period that has reached its paroxysm in 2012. The country situation was characterized by frequent electricity interruptions that have caused harm to the enterprises and houses. These outages constitute an economic slow-down factor but also an insecurity risk in the country due to the resulted social troubles.

This critical situation has driven the country to implement a certain number of mechanisms that have helped enhancing the electrical energy demand satisfaction of the country via a restructuring of the energy sector program.

It is in this framework that the energy urgency plan was put and has funded urgent and necessary investments to overcome the production deficit obstructing the development of the economy of the country and let serious obstacles hover on the uncontrollable agitation risks of the social tissue.

Thus, since 2013, the State has mainly invested in the production; which is translated during this period by the production cost and the operation fees decrease and the enhancement of the financial situation.

In fact, in 2015, SENELEC made a turnover of 12 billions of F CFA.

In the actual context, through its new strategic plan 2016-2020, SENELEC wants to reach a modern and powerful mutation that will help it to reach a total production of 3527.6 GWh in the year 2020 with a turnover of 339 billion CFA F.

In this way the total available power on the production field level is overcome by 573 MW in 2011 to 821 MW in 2016 and the number of outage hours that was 900 hours in 2011 is below 80 hours in 2016.

Therefore, despite the production capacity in increase on the national level and the important advancements, the energy sector is always facing obstacles and challenges of different types. In fact, the share of the available energy for each house remain insufficient to promote the emergence and the socioeconomic development despite SENELEC efforts.

In this context, the project for the construction and operation of the Malicounda thermal power plant was initiated by SENELEC who, by its completion, will enter a new energy era and during which the energetic self-sufficiency will become a reality all over the country.

II.2. Project Justification

The Malicounda power plant is the fourth IPP power plant running on heavy fuel and is part of a SENELEC program in the frame of the new Policy Letter on the Energy Sector Development (LPDSE/2013-2017) which aims to reduce the production gap in the whole country.

In this new letter, the energy strategy of the government is divided to many axes with mainly the development and operation of national energetic potentials, the diversification of energetic mix, the acceleration of electricity access and the restructuring of the sub-sector of electricity in the aim of a bigger efficiency and a judicious implication of the private sector.

In this way, after Kounoune Power (Dakar region), Tobene Power (Thies region) and Contour Global (Dakar region), we will assist the arrival of Malicounda thermal power plant, that will be seen by a clear enhancement of the service quality and will permit to end the structural deficit situation registered during the last years.

All these additional electricity capacities allow the optimization of production means with a durable guarantee of the offer-demand balance.

II.3. Objectives of the ESIA

The study shows the project characteristics. This description must cover the whole production process with mainly the definition of information related to operation modalities and identification of environment emissions. The ESIA objective is to ensure the environmental considerations taking into account in the decisions concerning the Malicounda power plant implementation project and which can have an impact on the environment.

However, the ESIA identifies, predicts and analyzes the power plant impacts on the biophysical, social, cultural environment and on the health of the populations and employees.

In other terms, the impact study will present a premises state on the environmental and social situation of the project. It will present also the applied methods to optimize the positive effects and restrict to the minimum the negative effects of the project on the biophysical and human environment.

More concretely, this study allows:

- To indicate the regulatory obligations to be respected during the implementation and operation phases;
- To describe the receiving environment of the project;
- To identify the possible environmental impacts (positive and negative) related to the implementation and operation activities on the environmental components of the project area;
- To guarantee the efficient use of resources;
- To provide strategies to enhance the social aspects;
- To identify and to set up the suitable measures to eliminate, reduce or compensate the major negative impacts through the Environmental and Social Management Plan (ESMP);
- To give orientations and recommendations to help decision-makers to take appropriate decisions;
- To propose measures to avoid the serious and irreversible damages on the environment;
- To inform the populations that might get affected by the project.

II.4. Method to Achieve the EISA

The impact study was guided by the prescriptions of the Senegal environment Code and related texts, allowing to identify and evaluate the actual knowledge, the project impacts on the environment.

It takes also into account the regulatory requirements expressed in sectorial codes, when they are applicable to the project. Therefore, for more respect of the national legislation, this project is subject to the requirements of the African Development Bank which has developed Operational Safeguards allowing the risks and impacts management in a way to follow the project activities in a lasting manner and by the same occasion, reinforce the development opportunities. In practice, the ESIA is established in four (04) stages:

STAGE 1: Study launching workshop

- Elaboration of the site project maps and its immediate surroundings in collaboration with the promoter;
- Identification of stakeholders (local collectivities, State representatives, populations etc.);
- Gathering of documents relevant for the study among interested persons;
- Analysis of data and site visit preparation.

STAGE 2 : Site Visit

- Malicounda power plant site visit by the EES cabinet team;
- Sensitive areas tracking;
- Identification of suitable areas for the noise and air quality measures;
- Information collection and complementary research;
- Public consultation of technical services of the State and coastline site populations.

STAGE 3: Interim report redaction

- Impacts identification and evaluation;
- Risks and pre-risk study realization;
- ESMP elaboration;
- Exchange with the promoter over the report content.

STAGE 4: Final report

- Validation of the interim report with the promoter;
- Correction and issuance of the final report.

II.4.1.DATA COLLECTION

The collection was made through meetings with the promoter to dispose data relative to the project (plans, technical, judicial, financial documents, etc.), of a documentary research, site inspections, consultations and interviews with main involved actors.

The documentary research consisted essentially of collecting information on the biophysical and socio-economic characteristics of the influence zone of the project as well as the political, legal and regulatory frame ruling the environment and the energetic infrastructures in Senegal. The consulted documents figure in the bibliography that will be attached to the report annex.

Then, land visits were made on the site and its influence zone. These visits allowed to the consultant to make the recognition of the land, to appreciate the studied zone, to verify and validate the collected information of the documentary research, to collect relevant information on the biophysical and socio-economic characteristics and to appreciate the environmental and social areas.

Group and individual interviews were conducted with the involved actors and concerned technical services of the State in order to pass the information on the project and gather their opinions, concerns, recommendations and expectations (see list of the encountered persons in annex).

A consideration of the results during the stakeholders' consultations reunions allowed to the consultant to identify the delicate points in relation different study referential.

II.4.2. DATA PROCESSING, ANALYSIS AND REPORT DRAFTING

This stage consists on treating, analyzing and synthesize the collected information in the previous stage.

Then an environmental analysis consisting at identifying and evaluating the negative and positive modifications of the project on the biophysical and human environment was conducted.

II.5. STRUCTURE DE THE ESIA

The presentation of this impacts study is structured as follows:

- Chapter 1: Non-technical Summary
- Chapter 2: Introduction
- Chapter 3: Project description
- Chapter 4: Political, judicial and institutional framework
- Chapter 5: Description of the initial environment
- Chapter 6: Analysis of the variants
- Chapter 7: Public consultation
- Chapter 8: Results of the analysis of the environmental and social impacts
- Chapter 9: Risks Assessment
- Chapter 10: Environmental and Social Management Plan
- Chapter 11: Conclusion
- Chapter 12: Annexes

II.6. PRESENTATION OF EES CABINET

The EES cabinet is a planning and conception office, consulting engineering for the industry, local collectivities, development organisms, administration, etc.

Being a ministerial representative of the Ministry in charge of the environment as well as the Directorate of the Civil Protection (DPD) for the realization of Risks Study (EDD) and the Internal Operation Plan (POI), the EES cabinet held many activities valid by the DEEC with the participation of DPC.

EES is a multidisciplinary experts' group of a high level involved in the energy, chemistry, petrol chemistry, agrobusiness, food industry, pharmaceutical industry and the BTP. The involved domains of the EES cabinet concern the diagnostic of emissions and immissions, engineering and advice, quality, environment, hygiene and security, trainings and assistance.

II.7. COMPOSITION OF THE TEAM

The environmental and social impact study of the project of the construction and operation of the Malicounda thermal power plant is realized by the EES cabinet with multidisciplinary team presented in the following table:

Table 12:Team of Experts

Name and family name	Title	Tasks in the ESIA
Serigne M. DIOP	Expert in industrial pollution, registered environmentalist	ESIA coordinator
Abdourahim BA	HSE engineer	ESIA report coordinator
Mbaye SARR	Socio-economist	Human and socio-economic expertise
Seynabou DIATTA	Geographer / environmentalist	Report coordinator, initial environment description, their impacts and cartography
Fatimata SAMBA	HSE engineer	Project description and the variants presentation
Victorin VEDOGBETON	Expert in hydraulics	General presentation of the project
Ndeye Marie LETTE	Geotechnical engineer/HSE	Risks assessment
Malick DIALLO	Socio-economist	Human and socio-economic expertise
Ndèye Fatou MBOW	HSE engineer	public consultation
Moutalla DIOP	Socio-economist	Human and socio-economic expertise
Yacine DIOP	Socio-economist	Human and socio-economic expertise, social inclusion
Khalifa Diop	Sound engineer	Initial sound environment study

III. PROJECT DESCRIPTION

III.1. Presentation of Project Company

SENELEC is a joint stock company with capitals mostly public, electrical energy production Concessionaires, transportation Concessionaires, distribution and retail Concessionaires but also, identification, finance and realization of new projects. The State ensure the regulation and the control of the sector for the efficiency research of the economic system in view of the strategic position of the electric industry in the national economy.

The State provides these functions through the Ministry responsible of the energy that provides the administrative and technical guardianship of the energy sector by the intermediate of the Directorate of the Electricity and the Commission of Regulation of the Energy Sector. SENELEC, was seen conferring the transportation monopole on the whole territory, plays the role of the unique purchaser. In this term, it purchases the electrical energy from the independent producers.

SENELEC has the monopole of distribution and retailer inside the Concession Perimeter, knowing that in the term of a defined period in its concession contract, the big clients can supply the producer they choose.

Since its creation in 1983 (state-ownership effective, the State created by the law n° 83-72 of 05/07/1983, a joint-stock company: The National Electricity Company, SENELEC was one of the most dynamic engines of the economic and social development of Senegal.

Today, the main challenge that the company has to face is the funding of its development in a characterized context by the globalization of the worldwide economy. To guarantee the success of SENELEC, the Senegalese government has adopted a certain number of texts predicting the liberalization of the sector through the opening of the production segment at the private sector for the realization and the management of electric power plants.

III.2. Project Organization

In this project framework, SENELEC and Malicounda Power are responsible for the necessary administrative and technical operations for the realization of the project. At this stage of the project, they assume the responsibility of conducting prior studies to the project implementation

However, it is important to mention that the construction and the operation of Malicounda thermal power plant was entrusted to an independent producer with whom SENELEC has signed a contract of type « Build, Own Operate and Transfer (BOOT) ». The transfer to SENELEC will take place once the contract reaches its term of 20 years of operation.

The project implementation will be a co-development between SENELEC, Africa 50 and Melec Power Gen /Matelec group who will enter into a shareholder agreement.

In the report, SENELEC and Malicounda Power, in term of one entity, are then called the « Project » or the « Proponent ». The "Project Company" designates SENELEC, Africa 50 and the Melec Power Gen /Matelec group.

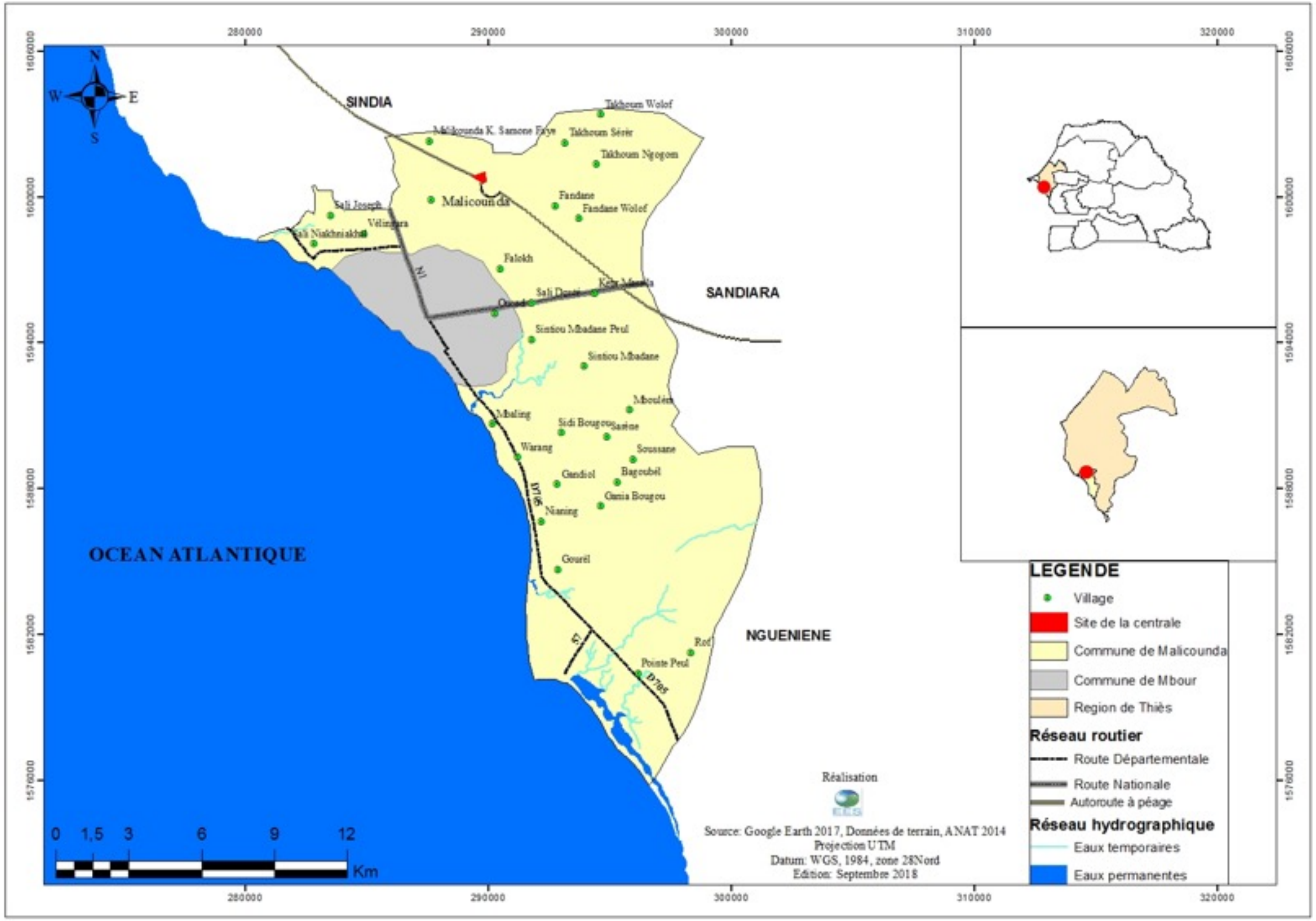
III.3. Localization of project

The power plant will be built on the Malicounda site situated in the Mbour Department, taking place in the same name commune, to be taken of 18 ha attributed to SENELEC by the village of Malicounda Wolof, one of the 22 villages of the commune.

The following table informs about the site coordinates.

Table 13 : UTM site coordinates

UTM Coordinates					
Points	**X**	**Y**	Points	**X**	**Y**
D	289 926,30	1 600 813,03	I	289 614,74	1 600 764,02
E	289 921,02	1 600 846,40	J	289 660,12	1 600 677,03
F	289 852,15	1 600 978,40	K	289 709,01	1 600 623,05
G	289 647,66	1 600 871,71	L	289 749,10	1 600 643,96
H	289 684,78	1 600 800,56	M	289 717,62	1 600 704,15



Map 2 : Localization of the Malicounda power plant site

Legend: Village/Site of the power plant/Commune of Malicounda/Commune of Mbour/Region of Thiès/Road network/ Secondary road/Highway/Toll road/Hydrographic network/Temporary waters/ Permanent waters

III.4. Presentation of the technical components of the project

III.4.1. General Presentation of Project

The project consists of the construction and operation of a fuel thermal power plant of 120 MW running on heavy fuel, equipped with new identical reciprocating engines in continuous service on the Malicounda site.

The power plant includes seven (07) reciprocating engines running on fuel, each with an 18 MW capacity. A combined cycle is also expected which will allow the increase the system of performance. The integration of the combined cycle will allow the production thanks to 01 large steam turbine.

Malicounda power plant uses first of all the heavy fuel oil as a fuel, then plans to be converted to use the gas, when its use of this last one will become available in Senegal (by the year 2021).

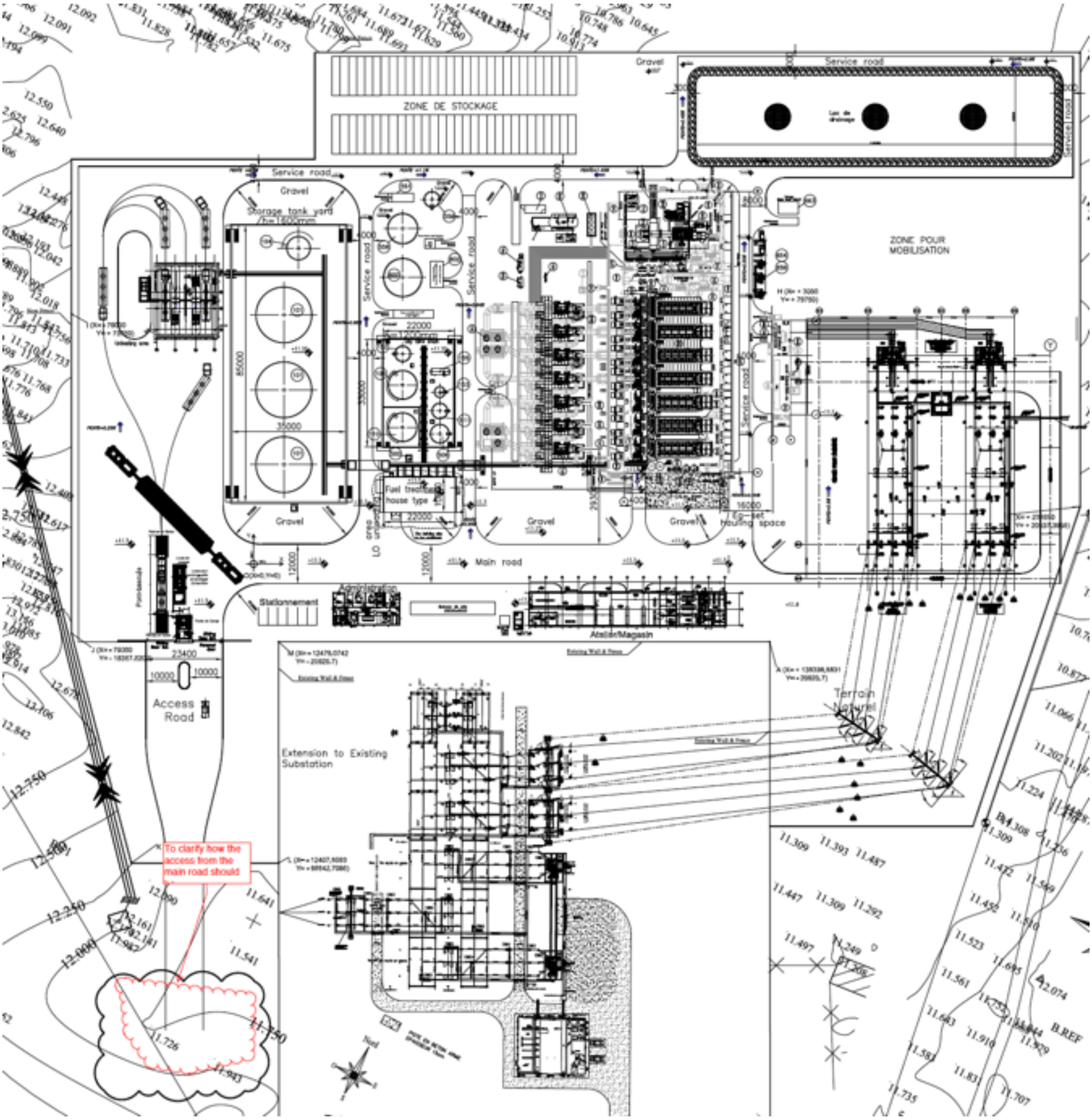


Figure 2 : Layout of the Power Plant

III.4.1.1. PRINCIPLE OF THE COMBINED CYCLE THERMAL POWER PLANT OPERATION

The operating process of the power plant involves different stages (see figure 1):

- Unloading, storage, fuel reheating;
- The reheated fuel is then purified, separated and is sent into the engines for combustion;
- On the engine level, the air is aspired and injected in the cylinder through a turbo compressor, of which the engine-turbine is activated by the exhaust gas. The engine cylinders are then stuffed in the air (air excess) which promotes the acquisition of a good combustion. After its admission in the cylinder, the air is compressed with the piston top. The temperature of the air becomes very high. At this moment, the purified and filtered heavy fuel is injected in the cylinder. The mix flames up and the calorific energy is transformed into mechanical energy that pushes back a piston in its cylinder.
- The transfer movement of the pistons is translated into a rotation movement of the rotor of the engine which is coupled to the generator rotor. This last one transforms the mechanical energy into electrical energy;
- The cold water coming from the heater allows to ensure the cooling of the parts surrounding the engine. The lubrication of these is done with new or refreshed lube oil;
- The exhaust gas of the engine is evacuated towards the stack pipes;
- In the case of a combined-cycle, the hot gas is used to produce steam thanks to the recuperation heater. This produced steam will activate a steam turbine that, coupled to a generator will produce electricity.

The following figure is an illustration of the principle of functioning of a fuel power plant.

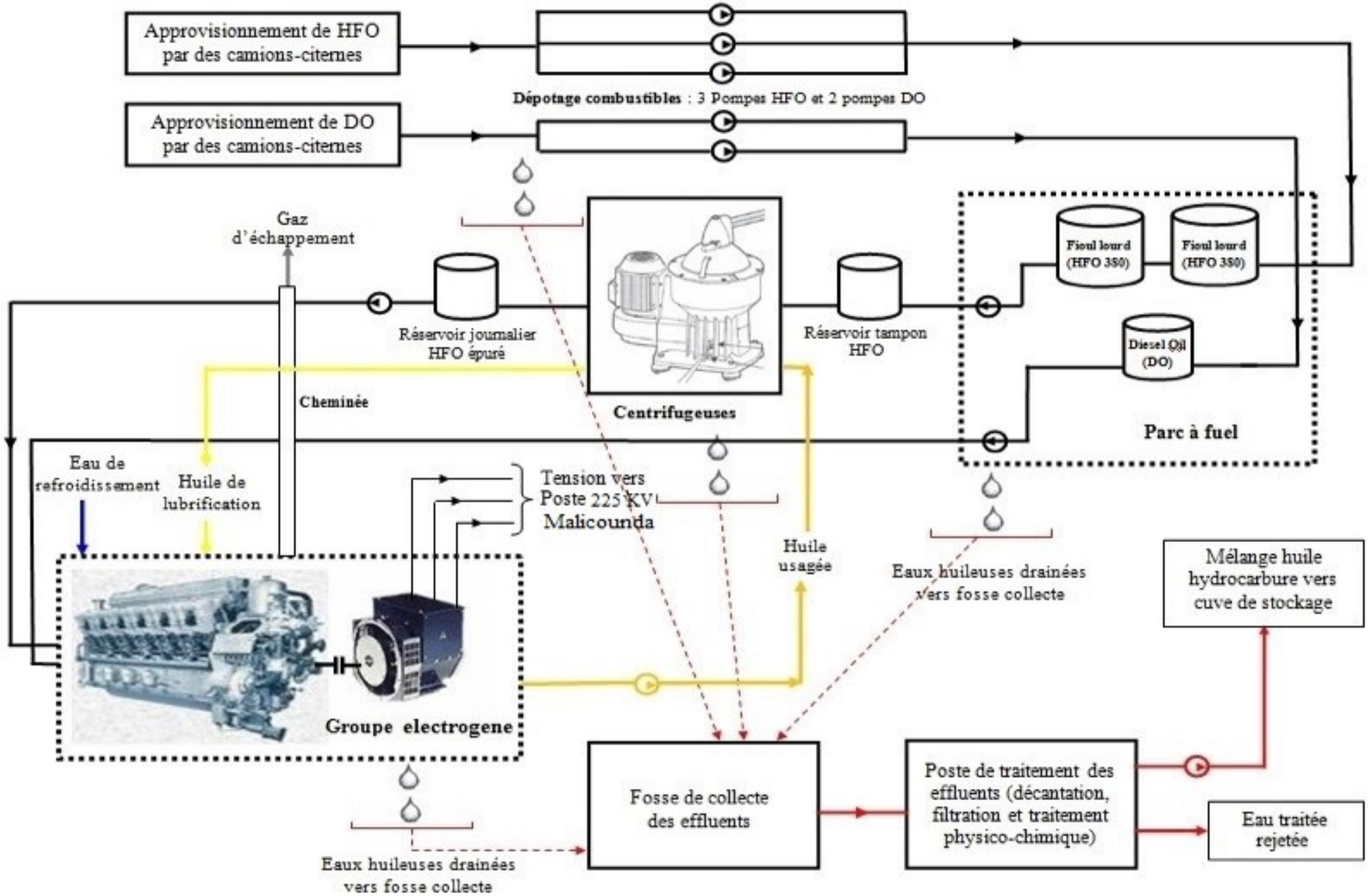


Figure 3: Functioning Process of a Fuel Power Plant

Legend: Supply of the HFO via tank trucks-fuel decanting- Supply of DO via tank trucks- Heavy fuel (HFO 350)-Heavy fuel (HFO 350)-Diesel oil (DO)- HFO buffer tank-Centrifuge system-Refined HFO daily supply tank-Exhaust gas-Generator set: cooling water- Lubricating oil- Chimney- Voltage to Malicounda post of 225 KV-Used oil-Oiled water drained away into a collector pit-Waste collector pit-Waste treatment station(decanting- filtration and physico-chemical treatment)- Hydrocarbon oil mixing into the storage tank- Discharged treated water

III.4.1.2. Power plant equipment

III.4.1.2.1. Diesel Engines

The power plant will have seven (07) functional engines and a steam turbine. Each engine has a capacity of 18MW. The electrogenic units permit the transformation of the mechanical energy into electrical energy through a process called “magnetic induction”.

The fuel combustion in the cylinders, induce the rotation of the crankshaft following the pistons movements. This crank movement induce then a rotation on the rotor’s level of the alternator which, by its rotation, generate a magnetic field allowing the electricity production.

The electricity produced by these engines will be led by a distribution network of SENELEC via the substation.

III.4.1.2.2. Separators

The centrifuges or separation units are conceived for the cleansing of the fuel and lubrication oil of the fuel engines.

The acceptable capacity of solid particles in the storage tanks is 880 ppm before any prior treatment. However, according to the date prescribed by the manufacturers, the maximum content in solid particles acceptable for the engine’s supply is 15 ppm. This explains the necessity of the HFO separation via separation for an optimization of the lifetime of these engines.

In other terms, in order to be consumed directly by the engines, it is necessary to purify the heavy fuel and to maintain it at an adequate temperature. The separators allow then to remove the water and the harmful impurities to the fuel engine.

III.4.1.2.3. Stacks

The exhaust piping after the crossing through the recuperation heaters will be regrouped to finally be discharged through the stacks. The crossing through the heater will allow to the exhaust gas to lose a part of its energy in the form of heat, then the emission temperature will be reduced.

For an optimal dispersion of the surrounding emissions of the power plant, it is essential to take into consideration the output temperature of these last ones. In fact, when these two are higher than the ambient temperature, the smokes are lighter and will tend to increase upward.

The dispersion and the diffusion of the effluent gas depend also on the wind speed that will increase with the altitude. Higher the wind gets, lower the pollution levels are.

In the frame of this project, it was decided to install seven (07) stacks of a 42 m height and a diameter of 1.6m. These two will be regrouped in two (02) stack groups

III.4.1.2.4. Combined cycle

A combined-cycle plant allows with the same fuel quantity to have a better efficiency by using the heat of the gas emitted from the electrogenic engines through the implementation of the recuperation boilers. This heat is transferred to the water to form a high temperature and pressure water steam that might activate the rotation of a steam turbine that will generate electricity when coupled to the alternator.

In other terms, the boiler’s role in the combined-cycle will be essentially to recuperate the maximum thermal energy coming from the engines exhaust gas and to transfer to the water in order to make high temperature and high pressure steam.

III.4.1.2.5. Recovery Boilers

The recovery boiler is constituted of three (03) serially connected exchangers: the economizer, the steamer and the over-heater. These exchangers are located perpendicularly in a smoke flue.

The support pump extracts water to send it into the heater where it will be reheated on a high temperature and a high pressure. This water passes first of all through economizer tubes, then through the steamer where it will be transformed into steam. This last one pass through the heaters where it reaches its maximum characteristics.

Once sent to the turbine, the steam will expand in the high pressure (HP) body from where it escapes. Coming again to the heater, it circulates in the over-heaters and goes back to the turbine.

After the expansion in the Average Pressure (AP) body and then the Low Pressure (LP), the steam gets out to the condenser where it will come back to the liquid state. The condensed water is again pumped via the re-heater station towards the boiler and the cycle starts again.

III.4.1.2.6. Steam Turbine

The engines will be linked to a steam turbine. The hot gas issued from the engines pass through the boiler, which allows to produce steam. This one will be led towards the turbine whenever activated will cause the rotation of the alternator via its rotor. At the turbine's level, the recuperated part of the thermal energy in the reheated steam is converted onto mechanical energy by the rotation of the rotor-stator couple.

III.4.1.2.7. Condenser

The condenser is an exhaust turbine that is an integral part of the combined cycle. It recuperates the hot steams issued from the turbine to make them circulate around its tubes and then condensate them.

The condenser has two (02) vacuum pumps and two (02) condensate extraction pumps, important for its functioning. The vacuum positioning in the condenser's sink is the condition for a good cycle performance.

Each pump can ensure the extraction of all the condensates and functions in normal/relief mode.

This condensate is then forwarded toward the air coolers to decrease its temperature by a heat exchange with the air. This water, refreshed afterwards, can be reused in the power plant that will have one (01) condenser.

III.4.1.2.8. Generator

The last production chain link, the alternator transforms the mechanical energy onto electrical energy received by the turbine to which it was coupled.

This transformation is produced through the rotor's rotation to induce electrical current in the fixed coils.

In order to become a powerful electromagnet, the rotor must be supplied with direct current by a generator, the excitatory.

III.4.1.2.9. Substation

A substation is composed of like its name indicates, transformers. It serves mainly to adjust the tension and intensity of the current provided by the power plant, to be integrated in the network.

The site is already provided with an electrical substation of 225 kV. An extension to the existing substation and to the substation of type 90 MVA /225/15 kV will be constructed and connected to this station.

III.4.1.3. AUXILIARY BUILDINGS

This building will receive the fuel centrifuges, the unloading pumps, the fuel supply, etc.

III.4.1.4. Fuel Tank farm

The construction of three (03) heavy fuel storage tanks (HFO) of 3000 m^3 each, one (01) buffer tank of 560 m^3, one (01) treated heavy fuel tank of 560 m^3 and one (01) light fuel tank (LFO) of 200 m^3, is expected.

The HFO filling of the 3000 m^3 tanks will be done by the trucks and the supply and the pose of two (02) unloading pumps, one in normal functioning and the second in relief, a mass-rate reception counter on each tank.

The LFO (gasoil) filling of the 200 m^3 tank will be done by the tank trucks and the supply and the pose of an unloading pump and a mass-rate reception counter.

The information coming from the counters will be transmitted to the inspection station. A local billboard is expected to be put on each counter.

The tanks will be equipped with an overflow prevention system and a leaking detection system. These storage tanks will have many security systems like:

- The valve of pressure-overpressure that allows to control the pressure and avoids any system explosion or implosion;
- The blowhole tank plays an aeration role as well as captors to monitor different parameters (temperature, pressure, etc.) that might cause accidents.

The tanks will be regrouped in collecting tanks of dimensions that comply to the standards namely:

- 20 % of the maximum tank's capacity;
- The total capacity of the biggest tank.

III.4.1.5. Lube Oil Storage

As part of this project, will be also installed:

- A storage tank of 75 m^3 of new oil, equipped with a counter, an unloading pump, a back-up pump, an indicator for the visual level, for the supply of all the power plant engines;
- A used oil tank of 25 m^3 installed to receive polluted or used oils and equipped with transfer pumps from its content after the regeneration and the quality control in the new oil storage tank.
- A support oil tank 16 m^3 installed to receive the oil service tanks of the support groups and equipped with emptying and transfer pumps after works.

III.4.1.6. Demineralization station

The demineralized water is produced to avoid the scaling and the corrosion of different currents requiring water. It ensures the supply functions of the recuperation boilers in water and in back-up water for the cooling engines. The demineralization groups ensure the water supply if the centrifuges maneuver and the reagent containers.

The water demineralization is done by an ion-exchange process. Water passes at the beginning through a vertical sand filter, then an active carbon filter and at the end through a high concentration in ions unity (anions and cations) To ensure the regeneration of the resins (cationic and anionic), chemical products like the chlorohydrin or sulfuric acid for the cationic resins and sodium for the anionic resins will be used.

One (01) raw-water storage tank of 500 m^3 and one (01) demineralized-water tank of 80 m^3 will be installed in the framework of the project.

III.4.1.7. COMPRESSED-AIR SYSTEM

This system provides compressed-air to start-off the engine, to supply the instrumentation, the control devices and the tools (paint guns, pneumatic tools, etc.) This circuit provides fresh and dry clean air to the engine for an optimal combustion.

This system is composed of two (02) electro compressors. The air is refrigerated with an inter-stage refrigerator and a final refrigerator. Air is stored in a bottle by group, of sufficient capacity to ensure at least four (014) consecutive and equipped start-offs of the necessary security accessories.

An expander is installed on the air line at 30 strips. The air is expanded at 7 strips for the control compressed-air production important for the engine and the instrumentation. The compressed air is stored in a vertical bottle of 120 liters' capacity equipped with a security valve, manometer and isolation valves. The regulatory air must be dry and oil-free.

III.4.1.8. COOLING SYSTEM

The cooling system allows the evacuation of the heat quality resulting from the combustion in the fuel engine. The cooling system is composed of two (02) circuits operating in a closed-loop: one circuit at a High temperature (HT) and one circuit at Low Temperature (LOT). The cooling system functions as follows:

- The treated water by demineralization enter in contact with the hot parts of the engine and cools them, The HT circuit allows to cool the main engine parts, like the cylinders, the cylinder head, the valves, the seats, the gavage air and the turbos charging;
- The LT circuit uses the same principle and cools the second stage of the gavage air as well as the lubrication oil charged with lubricants and cools the engine bearing;
- The air having recuperated the heat is cooled by an external circuit to a radiator proper to each group. The cooling is from a type forced with electro-fans;
- The two (02) circuits (HT and LT) must be the subject of an anti-corrosion treatment specific for the chemical additives.

The project expects the implementation of radiators and fans put on the roof of the building containing the engines.

III.4.1.9. HEATING SYSTEM

The reheated steam availability is required for many auxiliary stations. Functions requiring reheated steam:

- The reheating of heavy fuel in the mud collectors' tanks of 3000 m^3, in order to have a compatible viscosity with the pumping towards the centrifuges;
- The heavy fuel reheating before centrifugation: reduction of the viscosity before centrifugation;
- The heavy fuel circuits tracing, to maintain the viscosity at an acceptable level for its circulation in the collectors;
- The engine oil and used oil reheating before purification by centrifugation;
- Effluents and mud reheating in order to treat them in the clarifying tanks and separators.

The overheated steam is produced by seven (07) recuperation boilers (RB), each heater is inserted in the pipeline of an engine.

The reheating system is a horizontal fire-tube, with an access scale to the equipment installed in the high part of the heater, completely calorified, including the water supply unities with the whole associated valves. The steam getting out from the heater is led towards the clarinet distribution steam alimenting the consumption equipment.

During the start-off or the shut-down phases, the steam production is ensured by an auxiliary heater, equipped with a gasoil burner. The exit steam is connected to the distribution clarinet. The same purge, treatment and washing operations are applied to this heater which is isolated once the recuperation boilers are operating.

The heating system must always maintain the temperature of stored fuel at a minimum value of 50°C.

III.4.1.10. SUMMARY OF MAJOR TECHNICAL COMPONENTS

Table 14: Main Equipment of the Malicounda Power Plant

Units	Components
Electricity production system	07 Wärtsilä engines 07 stocks 02 separators 01 auxiliary boiler
Combined-cycle	01 steam turbine 07 recuperation boiler 01 condenser
Heavy fuel storage	03 storage tank: 3.000 m^3 each 01-day tank: 560 m^3 01 buffer tank : 560 m^3
Light fuel storage (gasoil)	01 tank of 200 m^3
Lube Oil storage	01 fresh oil tank: 75 m^3 01 used oil tank: 25 m^3 01 service oil tank : 16 m^3
Water storage	01 raw water tank: 500 m^3 01 purified water tank: 80 m^3 01 fire water tank : 1 000 m^3
Substation	Transformer of type 90MVA/225/15 kV ONAF
Auxiliary buildings	Control room Administration block workshop Canteen Laboratory Support workshop Loading/unloading area Fire-fighting area

III.4.2. Main auxiliary buildings

III.4.2.1. Control room

A control room with a view of the engine room will be installed. From two (02) autonomous supervisory posts, it will allow to have all the information about the plant, the engines, their auxiliaries, the position of the breakers of the engines and the circuit breakers connecting to the station, etc.

A water-run state recording printer will be installed and connected to the supervisory station.

1. **Control and instrumentation system**

Start-up, coupling, incident recouping, power settings and machine shutdown will be made from the control room.

The automaticity level of the entire power plant is very high because it will be driven by Industrial Programmable Automates (API). The automatons take into account all operating parameters and ensure real-time driving with a very high level of reliability and safety.

III.4.2.2. Administrative block and store

An administrative block, a store (with a crane) and a mechanical workshop with at least the necessary equipment below will be installed: a parallel tower, a milling machine, a welding station (arch), worktables, stalls, a 60-ton press and two (02) drills. Regarding the administrative block, a building will house in addition to the toilets, administrative premises such as management and departments such as:

1. Human resources
2. Finance and accounting;
3. Production
4. Logistics
5. Security.

The plant will also have a refectory and laboratories.

III.4.2.3. Unloading area

To avoid incidents, the plant will consist of a one-way road 06m wide and a traffic plan.

This access track will be built next to the existing high-voltage line on a 20-metre corridor and will cross the HTA line underground.

The unloading rea will have to:

1. Have soil that can withstand the constraints of parking vehicles
2. make it possible to recover and evacuate liquids in the event of leaks.

The domes will be filled by gravity or pumping. The trucks will be equipped with devices such as:

1. the circuit breaker on truck batteries;
2. Grounding device
3. flexible drivers.

III.4.2.4. Firefighting block

The overall design of the facilities should reduce the risk of fire. Fire precautions are necessary, especially in view of the presence of reservoirs and hydrocarbon circuits on the site. They consist of the establishment of a detection network, a water protection network, foam and various mobile means.

In other terms, an efficient system to prevent or fight a fire should be conceived on the basis of the international norms N.F.P.A. (Codes 11, 13, 15, 20 and 850) and it will include:

- Fire water Storage tank of a capacity of 1000 m^3
- Fire detection system all over the power plant areas
- Pneumatic, heat and dust detection depend on the area and the operation of each area

- Fire pumps container containing an overpressure pump, an electric pump and a gasoil pump
- Foam fire equipped container with deluge valves and water/foam mixers
- Foam spout for the tanks and fuel station
- Fire detectors for all the risky areas
- Spray nozzles for the auxiliary groups
- Collectors with water tubes all over the power plant
- Water and foam hose for the tanks area
- Foam movable unity for the electricity-generators groups area and the turbine area
- Fire extinguishers for the administrative buildings, offices and control room.

III.4.2.5. COMMUNICATION AND SURVEILLANCE SYSTEM

The major structure concerned by the process surveillance is the control room. This unit is at the heart of the control and the good functioning of the power plant because it allows to monitor multiple parameters (temperature, energy consumption, the pH…) and to follow-up the production thanks to the information sent by the sensors

As for the site surveillance, it will be ensured by the security guards in order to ensure the staff and goods security, equipped with communication means and surveillance cameras at the access points.

III.4.2.6. SITE SECURITIZATION

The site fence is the requirement of the insurance companies for the protection of the installations and persons. The securitization of the site can be enhanced by the surveillance cameras, an alarm system, a permanent guarding and night lighting with movement sensor.

III.4.3. DESCRIPTION OF PRE-CONSTRUCTION AND CONSTRUCTION ACTIVITIES

III.4.3.1. LAND ACQUISITION AND SECURITIZATION

It is convenient to note that according to the decree N 726-1288 of 27 October 1972 concerning the lands allocation and de-allocation conditions, SENELEC has obtained the allocation of two lands of a respective surface area of 15 ha and 03 ha following the deliberation n°02/CRM of 27/01/2012 and the PV of deliberation of the Municipal Council of the Commune of Malicounda held on 13 June 2018. In addition, the municipal council has allotted a total surface of 18 ha to the project for the power plant construction and the whole site will be fenced. The matriculation process of the land is ongoing on the level of the Domains direction. However, it is important to mention that after the deliberations, SENELEC must compensate the owners of the lands situated on the rights-of-way of the site before any pre-construction work.

This is the Decree n° 2010-439 of 6 April 2010 abolishing and replacing the decree n°88-74 of 18 January 1988, that fixes the scale price of the vacant lots, built-up lands and square meters.

In the framework of this project, the targeted site will be the subject of a physical relocation for the houses situated in the security area defined by the risk study and the economic relocation that will induce assets loss for the villagers who lived from the retail income of the rainfall cultivations.

In conformity with the operational safeguard 2 of AfDB, the promoter must ensure a good compensation for the PAP and the reinstallation that enhance the life level and the global livelihood means. SENELEC looks after the respect of this OS and will pay the compensations to the concerned persons through the RAP which is now in progress.

III.4.3.2. DESCRIPTION OF WORKS

The works will be extended over a period of **18 months** and cover the following stages:

- Land preparation;
- Field installation;
- Site preparation;
- Network set up;
- Buildings construction and equipment installation.

Land preparation

These land preparations include:

- Brush-cutting, weeding and cutting of trees present in the power plant premises;
- Complete premises clearance;
- General landscaping.

Temporary installation of the field

This consists on identifying the material and tools warehousing locations following the available spaces and according the field installation plan. A space will be made for the material storage and field waste storage. Some buildings and equipment are necessary, such as the containerized offices and the shops. However, the listed infrastructures and equipment in the table will be present on the specific areas inside the project.

Table 15 : Necessary materials and equipment for the construction

Material and equipment	Minimum required number
Cement mixer of 500 and 800 liters	06
Needle shakers	06
Liaison vehicle 4*4 all lands	05
Dump truck $20m^3$	05
Crane truck	04
Charger 960 on tire	02
Leveler 140 G	02
Compactor 4 T	01
Excavator	01
Slip form workshop	01
Electric cutter and steel folder workshop	01
Strut	1500 units
Shuttering system	$1000m^2$
Scaffolding	$5000m^2$
Fabrication workshop	01
GEOMAX station	01
Automatic level	01
Pattern and various	-
Etc.	

The constructor pays particular attention to the electric installations being used on Malicounda site, in this case the station 225 kV. In fact, the station receives the energy coming from the interconnected network housing the HT station, equipped in 225 kV, operating in 90 kV, remote-controlled and with a digital control system. It is composed of:

- 01 double busbar;
- 01 lines (departure SOCOCIM)
- 01 lines HTA 30 kV;
- 02 transformation 225 kV;
- 02 power transformers.

Preparation of the site

These land preparation works include the following actions:

- Set up excavations for the concerned constructions inception, until the acquisition of an adequate resistance land;
- Leveling the platforms at selected ratings.

Realization of the network

These works include:

- Landscaping, supply and the implementation of channels on sand carpet in the bottom;
- The concrete manholes;
- The backfills compacted with multiple layers;
- The establishment of a land network put in the bottom. Control rooms established on the level of each liaison;
- The installation of electrical and communication networks (temporary and permanent);
- The construction of draining network (temporary and permanent) and run-off waters.

Construction of buildings and equipment installation

The realization of works will require big sand, cement, steel, reinforced steel, concrete and gravel quantities. These materials will be provided by the enterprises starting from the cement industry, reinforced steel drawing factories and stone quarries.

The necessary concrete quantity will be manufactured by the concrete station on the site. This quantity is hardly estimable at this stage.

After casting the flabs, the entrepreneurs start the erection of the steel metallic scaffold and then, the walls and roofs. At the same time, the construction of the air-coolers begins.

With a very precise schedule taking into consideration the deadlines of the delivery, infrastructures (drilling set up, offices implementation, coupling with station 225kV for the electricity supply, prior security system implementation, workshops and storage rooms' dischargements, etc.) will be implemented.

The auxiliary installation already manufactured in the factories in the forms of containers, will be made in parallel with the big materials such as turbines, heaters, pre-manufactured transformation station, pre-manufactured piping and tanks, etc.

The works will end with the exterior displacements such as the road paving and the landscaping.

The implementation and management of green spaces will be made according to the plan approved by the concerned services.

III.4.3.3. WATER SUPPLY DURING CONSTRUCTION

To ensure the power plant water supply during the different phases, one (01) borehole will be installed at the site. The estimated output during the construction phase is $6m^3/h$. the execution works will be done before the start-off of the construction works. However, staying close from DGPRE is very important for the advice and technical prescription concerning the drilling.

The untreated-water supply for the civil engineer and the other services as well as the drinking-water supply through an internal temporary network constructed at the beginning.

The necessary water quantity for the construction needs (water for the civil engineer) will be estimated with the enterprise in charge of the works.

In conformity with the Operational Safeguard 4 of AfDB the project company must implement economic measures financially possible suitable to enhance the consumption efficiency by the resources project such as water.

III.4.3.4. ELECTRICITY SUPPLY DURING CONSTRUCTION

The main electric supply source will be an average tension line 30 kV connected to the 225 kV substation of Malicounda situated on the premises site.

However, generators will be expected in case of failure. They will be put near the workshop they should supply.

For a rational energy use, the project company should comply with the Operational Safeguard 4 of the AfDB.

III.4.3.5. MATERIAL, EQUIPMENT AND STAFF TRANSPORTATION

The power plant site is mainly accessible by road, height of about 4 km and take its origin in approximately 80 from the national road 1 Diamniadio - Mbour.

The strip turnover length of the access road is 6 m and the houses are very close in some places.

It is to mention that the road structures in Senegal are dimensioned for the convoys which load per axle should not exceed the 13 tons.

The heavy existing road is limited in length at 4.85 m on the national road 1 until Mbao (SAR) with the presence of nine (09) removable footbridges.

The construction material will be transported by big trucks from Dakar region to other neighboring regions. These trucks will make intensive rotations among sand, stones, cement industries and the future power plant site.

The technical equipment (gensets, boilers, steam turbines, centrifuges, etc.) and the auxiliaries will be delivered at the Port Autonome of Dakar. They will be convoyed towards the site under guard. The same will happen for the whole road of the drilling workshop. Deviations from the normal road axe will be expected for the oversized convoys.

During this phase of construction material and tools transfer, SENELEC as well as the enterprise in charge should pay special attention to the security and safety of the crossed communities.

It is important to mention that the factory construction strategy wants also to use the prefabrication and pre-assembling methods in modules. They are entire elements of boilers, turbines, piping, demineralization station, etc. that will be delivered to Dakar port and transferred to the site by road. This will allow to reduce the construction activities on site.

Finally, the staff flow coming to the site with personal transportation means must be taken into consideration. Construction of access roads

The main access to the site will be the Diamniadio-Mbour road and from which a paved road leads directly to the site. It should be noted that the narrowness and condition of this road will not allow the transit of trucks and vehicles during the construction phase under optimal safe conditions. For example, SENELEC has obtained an agreement in principle with AGEROUTE for the use of an access road designed by the latter for the transport of large groups and equipment.

For the transport of construction materials and other necessities for construction purposes, the construction of a ramp connecting the plant to the road is highly recommended. All these options are currently being considered between SENELEC, Malicounda Power and Ageroute.

III.4.3.6. WASTE GENERATION AND MANAGEMENT DURING CONSTRUCTION

During construction, the waste will be produced by the various activities of the site.

Good waste management practices such as collection, sorting, recycling and disposal by appropriate and appropriate means will be applied.

Discharges of sanitary wastewater from temporary buildings (toilets...) and permanent facilities (showers, cafeteria, toilets, etc.) will be collected and stored in a temporary septic tank during the construction phase, then replaced by a permanent pit for the operation of the plant. It is estimated that approximately 50^{m3} of sanitary wastewater will be generated each month during the construction site. The septic tank will be drained by an approved provider at a rate of about three times a month.

The main solid waste generated during the construction phase will be:

1. excavated floors and excavation materials corresponding to the foundations of the main buildings;
2. household waste;
3. packaging of building materials and raw materials (cement bag, wooden crates,...);
4. materials from the work of large works (excess concrete...);
5. greasy waste, batteries, empty cans and other special waste.

The waste will be sorted according to its origin and the modalities of its treatment. Based on feedback from similar projects, the volumes of special waste produced during the construction phase are expected to be low, and most of the waste produced can easily be reprocessed through existing streams. In addition, approximately 20^{m3} of ordinary waste (i.e. one truck) will be generated each month.
In accordance with the AfDB's Operational Safeguard 4, the project company will ensure the reduction of hazardous and non-hazardous waste at the source and its treatment and disposal in an environmentally sound manner. A list of the main waste generated during construction and the means of disposal is presented at the table below.

Table 16 : Types of wastes during construction and disposal

Description	Disposal means
Recyclable waste	Public discharge
Construction waste (wood, steel, wires)	Recycling
Fermentable fraction of household waste	Authorized discharge
Engines cooling liquids	STEP
Moveable equipment’s used oils	Cement industries after recuperation by registered
Used tires	Cement industries
Metal waste	Recycling or temporary transit
Medical waste (following a fire or an accident)	Incineration in accordance with DEEC

III.4.3.7. LABOR NEEDS

The construction of the Malicounda thermal power plant will require a fairly large human capital, in the order of 400 employees.

The workforce will consist mainly of workers and laborer’s but also a skilled workforce preferably recruited at the project area level.

In accordance with the AfDB's Operational Safeguard 5, the employer will need to develop a human resources policy as well as procedures tailored to the nature, size of the project and the size of the workforce. It will also have to ensure a safe and healthy working environment for its employees.

The construction work will be entrusted after the tender to a senior subcontractor or a company in charge of the work that will outsource with service providers for the various phases of the work. All work will be carried out as far as possible by local companies specializing in the field under the supervision of engineers from the independent private producer designated for the operation of the plant. These companies will each have one or more work and storage areas in the right-of-way of the industrial site.

Companies will be in one or more of the following disciplines:
1. civil engineering and earthworks;
2. Buildings;
3. mechanical assembly;
4. electricity and instrumentation;
5. painting, calorification;
6. lifting;
7. (scaffolding, maintenance, etc.).

The proponent is required to ensure that its subcontracting companies have appropriate management systems that are compatible with the AfDB's Operational Safeguard 5.

III.4.4. DESCRIPTION OF ACTIVITIES IN OPERATION

During the operational phase, the bulk of the activities revolve around two (02) major activities, namely the operations and maintenance activities.

III.4.4.1. HUMAN RESOURCES MANAGEMENT

The plant will operate for much of the year and will stop between 21 and 52 days a year for scheduled, preventative or random maintenance. The plant will operate 24 hours a day with three quarters of 08 hours.

During the operational phase, the number of employees is estimated at about 70 people, of whom about ten are unskilled. As recommended, unskilled staff will preferably be recruited locally.

In accordance with the AfDB's Operational Safeguard 5, the employer will need to develop a human resources policy as well as procedures tailored to the nature, size of the project and the size of the workforce. It will also have to ensure a safe and healthy working environment for its employees.

In the event of the use of expatriate staff, the operator must comply with the AfDB's Operational Safeguard 5. To this end, migrant workers must be treated in accordance with local laws and enjoy the same working conditions as non-migrant workers doing similar work. SMEs and local industrial service companies will be an advantageous participant in these stops. The plant operator is required to ensure that its subcontractors have appropriate management systems that are compatible with the AfDB's Operational Safeguard 5.

The plant's organizational chart will highlight managers, mastery and skilled workers as well as maneuvering skills. In broad terms, it will include:

1. The position of head of power plant or site;
2. le service HSE ;
3. Operating department, including chemistry and watch crews;
4. Maintenance services incorporating the electrical and mechanical sections and the spare store;
5. The general administration department;
6. etc.

III.4.4.2. CHARACTERISTICS AND CONSUMPTION OF HEAVY FUEL OIL

III.4.4.2.1. Physical-chemical parameters of heavy fuel oil

Heavy fuel oil is mostly made up of crude oil. However, some undesirable substances are found there. These are essentially:

1. Water whose presence in large quantities reduces the calorific value of the fuel;
2. high-grade sediments affect the quality of combustion and can destroy injection pumps;
3. Sulphur whose high concentration can lead to corrosion of the recovery boiler walls and smoke disposal system (with a maximum allowable rate of 2% in weight).

Analysis of several Senstock HFO samples resulted in averages for different parameters of the Senstock. The results are recorded in the table below.

Table 17 : Senstock HFO Features

Parameters	Value	Units
Density	0.95	Kg/L
PCI	41265	KJ/Kg
Viscosity at 50°C	309	Cst
Water	0.015	% mass
Sodium	0.521	% mass
Asphaltenes	0.918	% mass
Ash	0.023	% mass
Sediments	0.025	% mass

III.4.4.2.2. Heavy fuel oil

From the storage pumps, the fuel is transferred to the storage tanks and then into a buffer tank. These tanks will be equipped with a fuel heating system to reduce its viscosity. The heavy fuel oil is then transferred to a separation module by fuel centrifuges. The purified and filtered heavy fuel oil is stored in a buffer tank that feeds the tank every day. It is from the latter tank that the groups will be supplied with fuel.

III.4.4.2.3. Heavy fuel oil consumption

The consumption of the Malicounda thermal power plant is estimated at 540 T/day for the operation of the seven (07) engines. A certain amount of light fuel oil (diesel oil) will also have to be used during the start-up phases of the different machines, a maximum amount of 200 m^3 of light fuel oil will be stored in the factory.

III.4.4.2.4. Transportation and handling of heavy fuel oil

Fuel will be transported by trucks with a capacity of 35 m^3 from Senstock and equipped with heating systems to prevent the product from freezing. Approximately 18 trucks with a capacity of 35 m^3 per truck are required to supply the plant with heavy fuel oil on a daily day.

To ensure an efficient operation of transport operations between Senstock and the Malicounda power plant, a constant number of 15 tankers should be assigned throughout the operation of the plant with heavy fuel oil as Fuel.

The general mechanical condition of these vehicles is not expected to fail. For reasons of compliance with the current road regulations, all vehicles made available will be subject to a pre-acceptance check.

In addition, it should be ensured that drivers who need to be trained and equipped with their PPE are empowered.

III.4.4.3. WATER CONSUMPTION

The water supply for the operation of the plant will be made through the completion of an effective freshwater production before the construction phase. The project involves the installation of a 500^{m3} raw water tank.

The daily flow of the borehole is 6 m3/h, sufficient to ensure the water supply of the plant. [3] The forecast technical characteristics of the borehole to be carried out are listed below:

1. Total depth of borehole: 240 m;
2. Drilling in recognition;
3. Complete logging operation (resistance, nuclear and PS) to clarify the different levels of predictive capture;
4. Length pumping chamber PVC cemented diameter 10"3/4: 137 m; diameter drill 15"1/2 10"3/4;
5. 4"1/2 diameter casing steel exhaure tube: 126 to 210 m with dielectric fitting at the base;
6. Drilling diameter 9"7/2: The exhaure tube must enter the pumping chamber on a mandatory length of 10 m very adequately cemented;
7. Stainless steel crepine level in diameter 4": 210 to 234 m deep, drill diameter 9"7/2;
8. Stainless steel decanter tube in diameter 4": 234 to 240 m deep, drilling diameter 9"7/2;
9. Gravel top: 150m;

At a depth of 240 m, the productive water table of the Maastrichtian's freshwater clay sands will be exploited. The only freshwater table for productive drilling is the only freshwater table.
Thus, given the hydrogeological context, the length of the pumping chamber of the borehole should be up to 137 m deep, below the brackish-to-salt water limestone. The annular space of the pumping chamber will be cemented along its entire length to prevent the intrusion of this saltwater during pumping. Indeed, the total and adequate cementing of the ring finger is an essential operation for the success and sustainability of the drilling.
In all cases, the plant operator must approach the DGPRE for the technical requirements related to the implementation of the borehole.

In the operational phase, the needs are related to:

1. Water needed for cleaning equipment and facilities and industrial activities;
2. The water needed for the fire system
3. drinking and sanitary water for human use.

As part of the project, water requirements are estimated at 240 $m^{3/day}$ or 7200 m^3 for the month. This amount is consumed according to the following distribution:

1. 90% consumed in production (demineralized water - softened water) or 6480 m^3 which includes the amount of water released that represents 40% of the total water needs;
2. 10% for fire-fighting water, locker room water, taps and the like, or 720 m^3.

It should be noted that the raw water from the borehole will be demineralized for specific use stations requiring high quality water, such as:

1. The HT and BT cooling system of the engines;
2. overheated water and steam production;
3. the maneuvering water supply of centrifuges;
4. Feeding the reagent bins
5. supplemental water from boilers.

A demineralized water storage facility with a capacity of 80 m^3 will be installed as part of this project. For fire safety, 1000^{m3} of water is provided for the fire network.

Drinking water needs will be assessed in the impact section.

In accordance with the AfDB's Operational Safeguard 4, the operator will have to implement financially feasible and cost-effective measures to improve the efficiency of consumption, through the project of resources such as water.

III.4.4.4. TRAFFIC

Traffic will be mainly due to the movement of vehicles from senior personnel, transport buses for shift and maintenance personnel, in and out of equipment delivery vehicles, consumables and parts of the Spare.

III.4.4.4.1. Sources of noise

In the operation phase of the plant, the most significant sources of noise that can affect the surrounding sound environment are:

1. diesel engines and their cooling system (radiator);
2. air compressors and turbo generators;
3. exhaust vents;
4. pumps and various rotating elements;
5. boilers and safety valves
6. electrical equipment such as transformers, insulators, etc.

A reference state the noise will be established in order to control the variations in noise level following the commissioning of the plant.

The next step will be to put in place an action plan to reduce noise levels through the application of the various measures that will involve the implementation of noise level measurements, the reduction of noise at the source and the consideration of distance between sources of noise and sensitive receivers such as residential areas, Public Receiving Institutions (ERP) schools, health facilities, places of worship, etc.

III.4.4.5. CHEMICAL PRODUCTS MANAGEMENT

Apart from the fuels and lubrication oils mentioned above, chemicals will be packaged in 200-litre drums, mostly transported by trucks or containers and stored on site for use in various locations:

1. resin regeneration in the demineralization system of raw water (sulphuric acid and sodium hydroxide);
2. to improve the quality of the cooling water of the engines and that of the boilers (Nalco 2000 used as a chemical degassing to remove oxygen from the cooling water and as a corrosion inhibitor);
3. for welding and maintenance operations of production and auxiliary equipment (Cellulosic Diluent and White Spirit);
4. electrical insulation and cooling of transformer coils (dielectric liquid made from mineral oil).

All of these products that can be stored and handled within the plant are presented in the next table. The use of chemicals, as well as fuels and oils, will be subject to special attention and procedures when operating the plant in accordance with the requirements of Operational Safeguard 4.

Table 18 : **List of chemicals that can be stored and handled**

Product Designation	Annual consumption/stored quantity	Type of packaging	Use in the process
Concentrated sulfuric acid (96%)	10000 liters	200 liters in PVC	Demineralization of the untreated water
Sodium hydroxide (5-50%)	8000 liters	200 liters in PVC	Demineralization of the untreated water
Nalco 2000 (corrosion inhibitor)	5000 liters	200 liters in PVC	Treatment of the cooling water

Cellulosic diluent	Depends on the frequency of use	PVC	Maintenance product
White Spirit	Depends on the frequency of use	Steel valve	Maintenance product
Dielectric oil	Depends on the transformer's type	Transformer tank	In the transformers

The different chemical products presented below will be all stored in a special area.

III.4.4.6. WASTE MANAGEMENT DURING OPERATIONS PHASE

The goal of this management system is to set-up procedures that take into consideration the sorting, the gathering, the storage, the manipulation, the responsibility, the control of the waste quantity, the waste inspections, the transportation and the disposal outside the site of the power plant.

The operator of the power plant will ensure the respect of the regulations defined by the Senegalese authorities in connection with the waste management.

The references used in the framework of this waste management plan are:

- Code of the environment;
- Norm NS 05-061 on the used waters;
- Norm NS 05-062 on the atmospheric pollution.

The power plant operator must also set-up a team responsible of the implementation of the waste management procedures. This team will be composed by the persons in charge identified in the below table.

Table 19 : Responsibilities of the waste management team

Persons in charge	Solid waste management	Liquid effluents management	Gas effluent management
HSE person in charge	Is responsible for the planning of the waste disposal outside the site by establishing a waste follow-up register, charged with weekly inspection of the waste management on the site with a waste disposal form outside the site.	He guarantees the efficiency of the used waters thanks to the data analysis, ensures the management and the coordination of the effluents gathering and the filling of the form.	He is responsible for the calendar and the management surveillance, ensures the air sampling, fills the forms of surveillance of the air quality and takes preventive or corrective measures.
Operation person in charge	He guarantees the efficiency of the sorting of wastes on the site and on the storage area and to submit the filled form to the HSE responsible.	He is in charge of the monitoring of the work done by the operator and the lab assistant.	-
Laboratory assistant	-	He makes the samplings and proceeds to the analysis.	-

Persons in charge	Solid waste management	Liquid effluents management	Gas effluent management
Operator	He is responsible for the daily inspection of wastes, ensures the transportation of the wastes towards the storage area and quantifies them.	He is responsible for the inspection tanks and containers, makes visual controls and ensures the emptying when needed.	-
The maintenance staff	He deposits and transports the wastes generated by the administrative buildings.	-	-

III.4.4.6.1. Liquid effluent management

The liquid effluents are generated by a certain number of equipment during the operation of the power plant. The effluents sources or liquid emissions are :

- The purges of the deconcentration of the air-coolers;
- The purges of the heaters;
- The oily emulsions issued by the parquets and the machines;
- industrial wastewater including contaminated soils;
- wastewater of the fuel handling and manipulation;
- wastewater of the demineralization station;
- runoff waters of the combustibles air storage;
- wastewater of the sanitary of the power plant.

The wastewater and mud waste management includes the treatment, storage and dischargements of mud in the bags and the gathering of treated waters in a sink. A channeling was implemented for the non-contaminated rainfall waters.

III.4.4.6.1.1 Sanitary wastewater management

The waters coming from lockers, workshops and the administrative building is led by the gravity towards the septic pool. The sanitary used waters will then be gathered by a registered supplier on regular basis.

III.4.4.6.1.2 Contaminated water management

The rainfall waters potentially contaminated coming from the dischargements area and the storage area are sent towards oils separators. Every oil separator pool is divided into five rooms. However, the waters coming from the machines room and the pool situated at the heaters area are directly sent to the effluents treatment unit. These contaminated waters are treated by oil separators then by the effluents treatment.

The wastewater issued from the demineralization station will be sent to a common sink. The leaking and emissions issued from the demineralization equipment and issued from the storage room of the acidic and basic products will be transferred to the sink as well.

The waters will be neutralized with the chlorohydrin acid (HCl) or the sodium hydroxide (NaOH) depending on the pH measured before their discharge from the sink. The neutralized waters will be poured out in the buffer sink.

III.4.4.6.1.3 Sludge Management

The sludge coming from oil separators, storage tanks, unloading area and sumps at the workshops are pumped towards the sludge separator situated in the effluents treating area.

All the dischargements of hydrocarbons coming from the units are collected into oil sinks and transferred directly to the sludge treating system. Oil coming from sumps put on the workshops level, machines rooms, pump rooms, stack area are directly sent to the sludge treating system via the discharge pumps.

The obtained sludge extracted from the separator basis are transferred towards the storage tanks and then eliminated by a registered enterprise. The obtained oily water at the surface of the separator is sent to a sink gathering and decantation.

A stitching will allow to send the water towards a chemical treating unit by flocculation/coagulation via a transfer pump. After chemical products are added and the water treated, water will be sent to a buffer sink. The oily water on the surface of the sink is sent to the de-oiler via a pump skimmer.

Starting from the buffer sink, the water, via a discharge pump is repressed through the draining channel or sent to sink of decantation for a new treatment depending on its quality (pH measure and its conductivity).

After the oil separation by a de-oiler, the water will be sent to the gathering sink and the decantation sink whereas the oil will be sent in an oil recuperation pool. Starting from this pool, the oil is sent in a mud storage tank and then eliminated by a registered entity.

For the effluent management samples are regularly taken and sent to the laboratory and the analysis on site is done for the parameters that might be treated on the laboratory level.

Water samples are also taken from the buffer tank in order to verify the conformity with the national and international standards, the following parameters are analyzed: pH**, temperature, in suspension substances, ammoniac, nitrogen, residual total chlorine, DBO5, oil and grease, total chrome, iron, copper, phosphorus, zinc, total coliforms.**

The possibility to sign local contracts, for the mud recuperation and oven burning will be also studied by the independent producer.

It is the same for the valorization of used oils by a registered structure (cement industry) in conformity with the interdepartmental agreed of the 25 October 2007 concerning the management of used oils in Senegal.

In view of the anticipated proportions for each type of waste, around 150 m3 of sludge and other oily effluents will be generated every month, requiring then between 9 and 10 trucks of a capacity of 20 m3 for the gathering towards a treating center,

There are in Senegal many specialized companies in the gathering and the treatment of wastes generated by the project. The list of registered structures by the MEDD is in the annex 8.

For the effluent's management, samples are made on a regular basis and sent to laboratories. An analysis is conducted on the site for the parameters that can be treated on the laboratory level.

III.4.4.6.2. Solid waste management

During the operation of the power plant, the size of the domestic wastes was not well evaluated. However, it was possible to do estimations starting from the functioning of similar structures; which had allowed to confirm that around 5 m^3 will be generated daily or about 1 800 m^3 each year.

Concerning the other wastes, the estimation of the proportions of each generated waste was done on the feedback basis of Kounoune and Tobene power plants. The annual quantity of produces waste (besides domestic waste) is estimated at less than 2100 m^3.

Therefore, in total, the annual waste quantity generated by Malicounda power plant is estimated at 3 900 m^3.

All these wastes will follow a management method that expects the gathering, sorting, recycling, storage. Awareness and the monitoring of the final destination of the waste. Every hazardous waste eliminated or recycled outside the site will be the subject of a bordereau follow-up.

Concerning the solid waste treatment, the specific areas will be discharged for a waste storage while waiting for a disposal by a registered company of the concerned services.

III.4.4.6.2.1 Non-Hazardous industrial waste managements (DIB)

The management method presented in the below table is to be implemented.

Table 20 : Management method of the non-hazardous industrial waste (DIB)

Waste Type	Management method
Uncontaminated wood	Gathering and storage, composting or energetic valorization
Uncontaminated cardboard	Gathering and storage, recycling with a specialized transferee or energetic valorization
Uncontaminated papers	Gathering and storage, recycling with a specialized transferee or energetic valorization
Plastic used for the packaging	Gathering and storage, recycling with a specialized transferee

III.4.4.6.2.2 Oily waste management

Special tanks are provided for the oily wastes. These containers are black and identified thanks to a written label « oily wastes » They are made special to contain the contaminated wastes to know **plastic, cardboard, papers, filters, metals, plastic flexibles and the EPI**.

All the employees are responsible of the waste disposal in the appropriate waste tank.

These waste tanks are equipped with a top and must be closed in permanence. They will be emptied on a daily basis and conducted towards the accumulation area of the site hazardous wastes. One emptied, they will be returned to their actual place.

III.4.4.6.2.3 Other hazardous waste management

Wastes tanks are designed for these types of waste and they are identified by label put at the level of the hazardous waste accumulation area. The concerned wastes are sanding waste, greasing oils, aerosols, chemical products containers, fluorescent lamps, resins and batteries.

These wastes should be transferred to the hazardous waste accumulation area once they are generated.

The hazardous waste accumulation area has limited access in order to avoid the accidents or the bad manipulation of the wastes temporary stored. The access to this area is authorized only to the trained employees and authorized by the HSE officer. This responsible has to check up daily the list of all the employees authorized to treat hazardous waste on the site.

III.4.4.6.2.4 Chemical waste management

The chemical wastes are one of the main causes of the pollution and special precautions must be taken during their manipulation. It is agreed to:

1. Minimize the use of the chemical products and not use more than recommended by the manufacturer and dilute at the highest reasonable quality;
2. Control the chemical product during use;
3. Control the chemical product after use.

When using new chemical products (soap, oil, grease. Etc.) It is essential to ensure that the product is biodegradable. Where appropriate, this chemical product must be passive after the oxidation period (8-12 hours.

The chemical wastes must be put in special containers. The content must be clearly defined on the container.

The responsible operation team must be contacted when the chemical waste is stored and take the arrangements for an adequate storage.

The following chemical wastes must be put in this rubric: pain waste, soot, used acids and basics.

The above-listed elements must be separately stored and not mixed in no case. The neutral chemical products must be added only environmentally by operation staff or by instructions written by the administration.

In short, the operator of the power plant must not only limit the waste production but also ensure the recuperation and the reusability of these wastes in an environment-friendly manner in conformity with the Operation Backup 4 of the AfDB.

FINAL DISPOSAL

Every registered enterprise identified for the hazardous waste disposal must provide for the power plant, gathering, transportation and final disposal of the hazardous wastes, including mud, used oils, hazardous solid wastes such as cloth and filters, etc.

According to the waste quality registered in the stored waste register, the HSE responsible proceeds to the disposal of wastes and fills the disposal form outside the site. In every waste transfer for the outside disposal, he must ensure that the transporter and the treating installation are registered structures. These last ones fill also the dedicated rubric that is returned towards its producer at the end of the process.

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III.4.4.6.3. Gas effluent management

The main combustible used by the fuel engines if the heavy fuel. The pollutants emitted at the stacks levels are essentially characterized by the presence of sulfur oxide (SO_2), nitrogen oxide (NO and NO_2), carbon monoxide (CO) and particular substances (PM_{10}). Greenhouse gas (CO_2, N_2O) will be emitted in the gas effluents. The limit value of the emissions in oxygen of the gas effluents of 5% in volume, are defined by the norm NS 05-062 on the atmospheric pollution.

Exhaust gas emitted by the fuel combustion activate the turbine (engine) of the turbo-compressor, before being taken towards a silence noise attenuation permitting to return the sound level to a value inferior or equal to 35 dB (A).

The exhaust gas passes then to a heater transformer (recuperation heater) where they cede a big part of their heat to the circulating water. They escape to the atmosphere at lower temperatures.

Each diesel engine will have its own vertical stack of a 42 m length. These stacks are classed to have at the end two (02) atmospheric discharge points. The stack 1 includes 4 kegs, and the stack 2 includes 3 kegs.

The control of the air quality is done by the intermediation of air quality surveillance network equipped with sampling points.

The parameters PM $_{10}$, NO $_2$, the SO $_2$ and the CO will be daily measured and communicated.

A contract of service is signed with a skilled enterprise charged in providing the technicians in air quality for the samples gathering and analysis. The HSE responsible has to give instructions for the gathering and analysis of the samples and the air quality follow-up forms.

He sets up preventive or corrective measures to be taken in function of the surveillance results;

- In case where the measures results are inferior to 90% of the air quality norm, there is no necessary action.
- In case where the results are between 90% and 100% of the air quality norm, a preventive action is taken by the filling of a request form for a preventive action,

In case where the results are below the air quality norm, it is recommended to request immediately a corrective action and to fill the form of the corrective measures

III.5. ICPE CLASSIFICATION OF INSTALLATION

The project consists in the construction of a fuel thermal power plant running on heavy fuel (FO2) with additional generation of steam then of electricity from the exhaust gas heat. Consequently, the activities targeted by the project are summarized in the below table.

Table 21 : Administrative classification of the Malicounda thermal power plant

Rubric	Installation or activity/Substance	Characteristics of the project	Classification ranking	Environmental evaluation type
A 1401	**Electricity production and distribution** (proceeded by a turbine and a steam generator) whatever the capacity is.	The power plant will have a capacity of 120 MW.	A	EIA

Rubric	Installation or activity/Substance	Characteristics of the project	Classification ranking	Environmental evaluation type
A 1402	**Electricity production and distribution by thermal power plants,** electrogenic diesel engines, etc.) If the maximum thermal capacity is above 2 MW	The power plant will install 07 diesel engines of a capacity of 18.6 MW.	A	EIA
A 1406	**Refrigeration or compression** The total absorbed power being above 200 kW above 20 kW t below 200 kW	The total power of the power plant compressors is 200 kW.	A	AEI
S 302	**Acid (use or storage d')** The maximum quantity to be stored above 5m3 and below 50 m3	The total quantity stored on the site is 10000 liters.	D	
S 304	**Alkaline or basic products (use or storage)** The maximum quantity to be stored above $5m^3$ and below 50 m^3	The total quantity stored on the site is 8000 l.	D	
S 702	**Storage of liquid combustibles** – Category D Storage capacity above 5000 m^3	The storage of heavy fuel is of a total capacity of 10120 m^3 (03 tanks of 3000 m^3 and 02 tanks of 560 m^3.	A	EIA
	Storage of liquid combustibles – Category C	The heavy fuel storage capacity is 200 m^3	A	AEI

Rubric	Installation or activity/Substance	Characteristics of the project	Classification ranking	Environmental evaluation type
	The storage capacity above 100 m^3 and below 4000 m^3			
S 703	**Inflammable liquids (mixed)** When the total nominal capacity equivalent is: above 1000 m^3	The heavy fuel total storage capacity is 10120 m^3. The light fuel storage capacity is 200 m^3.	A	EIA

In terms of the ICPE legislation (cf. Code of the Environment) Malicounda thermal power plant through its electric energy production activities, its equipment and hazardous substances implemented is a first class establishment. It is then subject to authorization and its realization requires a prior Impact Comprehensive Study (EIA). An ICPE file must be prepared by Malicounda Power and submitted to the DEEC.

IV. POLITICAL, INSTITUTIONAL AND JUDICIAL FRAMEWORK

The construction and operation of the Malicounda thermal power plant running on heavy fuel requires the current texts in relation with the political, institutional and judicial framework applicable to this project. To this end, an overview of the legal, regulatory and normative in force texts in Senegal and the ratified laws and conventions for the environment protection and conservation was done.

The ESIA concerning the industrial project of this magnitude implies strategies to help enhance the life conditions of the populations in their natural environments.

IV.1. ENVIRONMENTAL AND SOCIAL MANAGEMENT POLITICAL FRAMEWORK

The law n°2001-01 of 15 January 2001, concerning the Code of the Environment, highlights the obligations of a comprehensive ESIA for the first class industries such as Malicounda thermal power plant. Then, the most relevant orientation and planning exercises documents are presented in the following sub-chapters.

IV.1.1. POLITICAL, ECONOMIC AND SOCIAL FRAMEWORK AT A NATIONAL LEVEL

Few environmental and social policy texts which content and objectives are relevant to the project are summarized in the following.

Table 22 : Political Framework applicable to the Project

Political texts, content and objectives	Application in the project framework
The Emergent Senegalese Plan aims at launching the integrated plan of the electricity sub-sector through the following point: • Energy availability in sufficient quantity and quality; • A price among the lowest of the sub-region (~60 at 80 FCFA/kWh); Then, the actions will tackle the reinforcement of the electric network.	The project with its power of 120 MW will participate in the PSE objectives in terms of electricity supply.
The Policy Letter of the Energy Sector Development aims at a Senegal where the electrical energy is available in quality and in quantity, and is competitive and produced from technology diversities. Among the strategic axes selected in the LPDSE appears the guarantee of the energetic security and the energy access expansion for all people, to impulse a powerful economic growth and a social sustainable development.	These different strategies are in phase with the project implementation.
The Policy Letter of the Environment and Sustainable Development (LPD/SEDD) (2016-2020) has as objectives to "create a national system for the enhancement of the environmental and natural resources management, the integration of the sustainable development principles and the reinforcement of the impact strength of the populations to the climatic changes".	The project is an adequacy with the LPD/SEDD objectives
The National Action Plan for the Environment (PNAE) constitutes a strategic framework that allows to the Senegalese State to identify the environmental priorities and to define the efficient planning systems. One of these main objectives is to take into account the environmental dimension in the economic and social development planning.	The project must be subscribed in the conduct of the PNAE by ensuring the resources preservation.
Senegal has signed and ratified **the United Nations Convention to combat desertification** (CNULCD) and adopted in October 1998. Its national action plan to combat desertification (PAN/LCD), is the main instrument for the application of this convention on a national level. The	The project must take into consideration the requirements of the PAN/LCD for the preservation of the biodiversity.

Political texts, content and objectives	Application in the project framework
Senegalese State has actualized the PAN/LCD and it is now the PAN/LCDGDT.	
The Defined Contribution on the National Level (CDN) of Senegal integrated in the strategic and political framework is a strategic document declining the reduction of the greenhouse gas (GES) engagements by the year 2035, during Paris Agreement on the climate in 2015.	The promoter has to control the GES in conformity with the agreement signed in Paris.
Other strategic and political policies relevant to the project are listed below: • Forestry Policy of Senegal (PFS) (2005-2025); • National Agency for Land Displacement (ANAT); • Act III of the decentralization; • Sectoral Policy Letter of the Internal Governance (LPSGI); • The strategy of the implementation of the United Nations Convention on the Climate Changes; • The national supply strategy; • Its National Strategy and Action Plan for the Conservation of the Biodiversity; the CNUCC: convention on the biological diversity.	These relevant plans and policies contribute to better preserve the environment and natural resources.

IV.2. Environmental and Social Management Judicial Framework

IV.2.1. National judicial framework

In relation with the context and the activities of the project, the national legal framework is marked by many texts that tackle the environment and social aspects.

IV.2.1.1. Constitution Of Senegal

The Senegalese Constitution, adopted on the 22nd of January 2001 and reviewed on the 20th of March 2016 by a referendum, has introduced the important environmental provisions that must be taken into consideration in the different phases of the project. The article 8 of the Constitution guarantees the right to a healthy environment for all the people. This right is applied in laws and regulations framework.

The different texts have defined the implementation condition of such a right that must be guaranteed to the employees and the riparian populations of the power plant.

IV.2.1.2. Environmental code and its applicable texts

The law N°2001-01 of 15 January 2001 concerning the Code of the Environment makes from the environment a cultural heritage that must be protected and establish prevention and precaution general principles. The Code of the Environment includes all the environment sectors and has the main guidelines of a good management that we must respect no matter what the targeted domain is.

All these provisions ensure the efficient protection and management of the environment.

The below table gives a summary of the laws of the Code of the Environment.

Table 23 : Relevant parts of the Environmental Code of 2001 applicable to this project

Reference of the article or text	Relevant Content	Feasibility of the article or text
Code of the Environment (ART L 9)	« Impact Study »: every study prior to the project realization of the dischargements, equipment, installation, of industrial or agricultural plan or program, allowing to appreciate the direct and/or indirect consequences of the investment on the environment resources. Are put under the provisions of this law, the factories, workshops, fields and in general the industrial installations managed by a physical or moral person, public or private and other activities that represent the risks on the health, security, nature and the environment in general or disadvantages for the surrounding commodity.	The project is put in the category 1 of the ICPE nomenclature subject to the authorization. Its development requires the set-up of the Comprehensive Impact Study.
Code of the Environment (ART L30)	Every person that produces or holds waste must ensure the disposal or the recycling by itself or by a registered enterprise by the Ministry in charge of the environment. In default, the person has to take the waste to the local collectivities or other company registered in the state. This company or local collectivity can sign contracts with producers or waste holders for their recycling or disposal.	The operator of the power plant has to implement a waste management plan.
Code of the Environment (ART L 76)	Are subject to the present provisions of the law and regulations taken for its application, the air pollutions and odors that annoy the populations, compromise the health or the public security and, cause harm to the agriculture, the conservation of constructions and monuments. In the frame of the application of the international conventions, the State must take the general guidelines to reinforce the combat of air pollution.	The operator of the power plant has to take all necessary provisions for the preservation of the air quality.
Code of the Environment (ARTL 77)	Decrees made under the present law define: - the conditions of the commercial, industrial, agricultural establishments, vehicle or other moveable object used by a moral or a physical person in order to implement the provisions of the present law; - cases or conditions where it must be prohibited or regulated the construction of buildings or establishments not appearing in the nomenclature of the classified installations, the vehicles equipment, the fabrication of moveable objects, the use of combustibles or carburant when needed; - cases and conditions where every executive measure must be taken by the administration to hold back the trouble before the execution of penal convictions; - deadlines to be respected in accordance with the provisions on the date of publication of each regulation;	The operator of the power plant has to take all necessary provisions for the preservation of the air quality.

Reference of the article or text	Relevant Content	Feasibility of the article or text
	- protection zones being the subject of particular measures must, when needed, get instituted by a Minister order in charge of the environment in function of the pollution levels and taking into account certain circumstances willing to worsen the disadvantages.	
Code of the Environment (ART L 78)	In order to avoid the atmospheric pollution, the buildings, agricultural establishments, industrial and commercial, vehicles or any other moveable object used by a moral or a physical person in order to satisfy to the provisions of the present law; They are subject to the general obligation of prevention and reduction of harmful impacts.	The operator of the power plant has to respect the norms of the atmospheric pollutant's emissions.

- **Environmental Regulation and Norms**
    - **Air Quality preservation (NS 05-062)**

The norm NS 05-062 is a document that fixes the norm of atmospheric dischargements in Senegal according to the environmental principles. Its objective is to protect the environment and humans from the atmospheric pollution.

It is applicable to the fixed existing and new installations and to the vehicles emitting effluent gas. It includes limit values of emissions, including the fixed combustion engines.

Table 24 : Limit value of discharge of a pollutant in the air (Norm NS 05-62)

Substances	Debit	Discharge limit value
Total dust	D <= 1 kg/h D > 1 kg/h	100 mg/m^3 50 mg/m^3
Carbon Monoxide (CO) The authorization act fixes a limit value for the carbon monoxide		
Sulfur oxide (expressed in sulfur dioxide)	D > 25 kg/h	500 mg/m^3
Nitrogen oxide expressed in nitrogen dioxide	D > 25 kg/h	500 mg/m^3
Hydrogen chloride and other composed inorganic chloride gas (expressed in HCl)	D > 1 kg/h	50 mg/m^3
Ammonia and ammonium composed expressed in ammonia	D > 100 g/h	20 mg/m^3
Fluorine, fluoride and composed fluorinated (gas and particles)	D > 500 g/h	10 mg/m^3 for the gas 10mg/m^3 for the vehicles/particles 15mg/m^3 for the fabrication of phosphoric acid, phosphor and fertilizer
Total discharge in organic composed excluding methane and polycyclic aromatic Hydrocarbons (HAP)	D > 2 kg/h	150 mg/m^3
Polycyclic aromatic Hydrocarbons (HAP)	D > 2 kg/h	20 mg/m^3
Cadmium discharge, Mercury, and Thallium, and their composed (expressed in Cd + Hg + Ti)	D > 1g/h	0,2 mg/m^3
Arsenic discharge, Selenium and tellurium, and their composed (expressed in As + Se + Te)	D > 5 g/h	1 mg/m^3
Antimony discharge, chrome, cobalt, zinc, etain, nickel, lead, vanadium, zinc, and their composed (expressed in Sb + Cr + Co + Cu + Sn + Mn + Ni + Pb + V + Zn)	D > 25 g/h	5 mg/m^3
Phosphine, phosgene	D > 10 g/h	1 mg/m^3
Ammonia (for the fertilizers)	D > 100 g/h	50 mg/m^3

Table 25 : Limit values of concentrations of pollutants in the ambient air (Norm NS 05-062)

Substance	Emission limit value	Statistic definition
Sulfur dioxide (SO_2)	50 µg/m^3 125 µg/m^3	Annual average (arithmetic) day average
Nitrogen dioxide (NO_2)	200 µg/m^3 40 µg/m^3	Hourly average (arithmetic) Annual average
Carbon Monoxide (CO)	30 mg/m^3	Average on 24 h ; must not exceed more than one time per year
Ozone (O_3)	120 µg/m^3	Average on 8 hours (health for the population)
Dust in suspension (PM 10) (aerodynamic diameter below 10 µg)	80 µg/m^3 260 µg/m^3	Annual average (arithmetic) Average on 24 h ; must not exceed more than one time per year
Plomb (Pb) in the dust in suspension	2 µg/m^3	Annual average (arithmetic)
Cadmium (Cd) in the dust in suspension	1,5 nb/m^3	Annual average (arithmetic)
In the total dust fallouts	200 mg/m^2 x day	Annual average (arithmetic)
Plomb (Pb) in the dust fallouts	100 µg/m^2 x day	Annual average (arithmetic)
Cadmium (Cd) in the dust fallouts	2 µg/m^2 x day	Annual average (arithmetic)
Zinc (Zn) in the dust fallouts	400 µg/m^2 x day	Annual average (arithmetic)
Thallium in the dust fallouts	2 µg/m^2 x day	Annual average (arithmetic)

The activities of the power plant will emit atmospheric pollutants that must be in conformity with the present norm.

- **Preservation of the water quality (NS 05-061)**

The Senegalese norm NS 05-061 published in July 2001 fixes the limit value of the used waters quality in the natural environment and before being given to a collective purifying station. The norm fixes also the conditions of effluents spreading and dust.

Table 26 : Extracts of the Senegalese Norm NS 05-61, Wastewater-Norm of discharge

Limit value of the wastewater discharge in the natural environment	
Parameters	**Limit Value**
Substance in total suspension	50 mg/l
DBO5 (on non-decanted effluent)	80 mg/l if the authorized daily flow does not exceed 30 kg/d, 40 mg/l above
DCO (on non-decanted effluent)	200 mg/l if the authorized daily flow does not exceed 100 kg/d, 100 mg/l above
total nitrogen (organic nitrogen, ammoniac nitrogen, oxide nitrogen)	30 mg/l in average monthly concentration when the daily flow is equal or above à 50 kg/day

Limit value of the wastewater discharge in the natural environment	
Parameters	**Limit Value**
Total Phosphorus	10 mg/l in average concentration when the authorized daily flow is equal or above15 kg/day
Phenol index	0,5 mg/l if the discharge exceeds 5 g/day
Phenols	0,5 mg/l if the discharge exceeds 5g/d
Hexavalent Chromium	0,2 mg/l if the discharge exceeds 5 g/d
Cyanide	0,2 mg/l if the discharge exceeds 3 g/d
Arsenic and composed (in As)	0,3 mg/l if the discharge exceeds 3 g/d
Chrome (in Cr3)	1 mg/l if the discharge exceeds 10 g/d
Total Hydrocarbons	15 mg/l if the discharge exceeds 150 g/d
Fluor and composed (in F)	25 mg/l if the discharge exceeds 250 g/d

The construction and operation works must be done according to this norm.

- **Noise Protection**

There are no existing special norms regulating the sound emissions. However, the noise protection is governed by the Code of the Environment by the article L84.

Limit values vis-à-vis the human health (corresponding then to the limit values measured on the level of the nearest houses) are defined in the regulatory part of the Code of the Environment:

- 55 dB (0A) to 60 dB (A) of day;
- 40 dB (A) of night.

The Decree n° 2006-1252 of 15 November 2006 fixing the minimal guidelines of prevention of certain physical factors (Chapter IV. – Noise). We mention mainly the articles 13 and 14.

Art. 13. – the level of noise exposition must be the lowest possible and staying in an intensity limit that does not risk to affect the health of the employees especially the hearing.

Art. 14. – The level of daily sound exposition received by an employee during the daytime must not exceed the 85dB (A).

In term of the existing regulations concerning the noise, the promoter of the project has to comply with the following provisions:

- On the level of the nearest villages (targeted): the maximum audible levels not to be exceeded are of fifty-five (55) dB (A) the day and forty (40) dB (A) the night.[2]
- Taking into account the values related to noise in the choice of Individual Protection Equipment and collective, and that of the machines and equipment also during the construction and operation phases.

Other legal texts concerning also the environment and the management of natural resources and relevant to the project are listed below.

[2] IFC –EHS guideline –page 53-april 2007

IV.2.1.3. CODE OF WATER AND ITS RELEVANT TEXTS

The **Law n° 81-13 of 4 March 1981 concerning Code of the Water** was adopted in order to better rationalize the intervention of the public powers in the management of the natural resources.

It is the title II of this text (articles 47-63) relative to the qualitative protection of waters that tackles the most the water pollution.

Different decrees of application of the Code of water in 1981 were enacted:

- Decree n° 98-555 of 25 June 1998 tackling the application of the provisions of the Code of water relevant to the authorizations of construction;
- Decree n° 98-556 of 25 June 1998 tackling the application of the provisions of the Code of water relevant to water policy that concerns also the surface and underground waters.

All the provisions of the Code of water must be respected in the framework of this project.

IV.2.1.4. CODE OF HYGIENE

The law n°83-71 of 5 July 1983 concerning the Code of the hygiene regulates not only the individual hygiene but also the public and collective hygiene.

The chapter 6 of the first title of the Code treats the hygiene rules of commercial and industrial establishments.

The operator of the establishment must organize the sorting, the gathering and the disposal of the generated wastes.

IV.2.1.5. CODE OF SANITATION

This code was introduced under law n° 2009-24 of 8 July 2009 concerning the Code of the sanitation. The Code of the sanitation treats the effluent system of industrial origins in the section III of chapter IV.

Every installation that might discharge polluted water must join at its authorization request a file describing the activity type, and the purifying device expected to be put in conformity with the provisions of the current law, then the engagement of the depollution norms respect fixed by different codes and application texts (art. 53).

The decree n° 2011-245 of 17 February 2011 holds application of the law concerning the Code of the sanitation and the special provisions selected the waters of industrial origins (art. R. 19-26).

IV.2.1.6. CODE OF LABOR AND ITS NEW APPLICATION TEXTS

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In the implementation of the project, different relevant texts relevant to the health of the employees of the Malicounda Power Plant must be respected. Among those texts, we have:

- The Law n°97-17 of the first of December 1997 concerning the Code of work that fixes the work conditions, especially the work duration that must not exceed the 40 hours per week, the night work, the contract of women and children and the daily break which is obligatory;
- The Law n° 73-37 of 31 July 1973 concerning the Code of the social security modified by the Law N°97-05- 10 March 1997 tackling the work accidents and professional diseases in its title II;
- The decree n°67 -1359 of 29 December 1967 abolishing and replacing the articles 25 and 30 of the decree n°62-146 of 11 April 1962 organizing the workforce service;
- The decree n°94-244 of 7 March 1994 fixing the organization modalities and the functioning of the hygiene and work security committees

In 2006 new decrees have been added to the applied provisions. They are:

- decree n° 2006-1249 of 15 November 2006 fixing the minimal guidelines of security and health for the moveable or temporary fields;
- decree n° 2006-1250 of 15 November 2006 relative to the circulation of vehicles and engines inside the enterprise;
- decree n° 2006-1251 of 15 November 2006 relative to the work equipment;
- decree n° 2006-1252 of 15 November 2006 fixing the minimal guidelines of prevention of certain physical factors;
- decree n ° 2006-1253 of 15 November 2006 establishing a medical labor inspection and fixing its attributions;
- decree n° 2006-1254 of 15 November 2006 relative to the manual handling of charges;
- decree n° 2006-1256 of 15 November 2006 fixing the obligations of the employees in term of work security;
- decree n° 2006-1257 of 15 November 2006 fixing the minimal guidelines of protection from chemical risks;
- decree n° 2006-1258 of 15 November 2006 fixing the missions and rules of organization and functioning of the services of the occupational Medicine;
- decree n° 2006-1260 of 15 November 2006 relative to the workplace's aeration and handling conditions;
- decree n° 2006-1261 of 15 November 2006 fixing the general hygiene and security measures in the establishments.

The construction and operation phases of the power plant will require the use of a workforce that must be protected.

IV.2.1.7. Forest Code

The forest legislation finds its basis in the law n° 98-03 of 8 January 1998 including the forest Code, completed by its application decree n° 98-164 of 20 February 1998.The code governs the vegetable resources and the protected spaces. The procedures of land-clearing are described in the chapter 2 of the decree including the application of the forest code to its Art. R.47 to Art. R. 55. In the framework of this project, the release works will require tree cutting partially protected (*Adansonia Digitata*) and land-clearing. These activities will be done in conformity with the provisions of this code.

IV.2.1.8. Code of Urbanism

The regulatory part of the code includes chapter III dedicated to the industrial establishments and a chapter IV relative to the classified establishments. Any construction authorization is subordinated to the prior authorization of the services of the Ministries in charge of the classified establishments and the Civil Protection (Art. R. 367) by indicating all the necessary information of the article R. 368 of the code. Malicounda thermal power plant is a classified installation. Consequently, the promoter should hold a construction authorization following the provisions of this code.

IV.2.1.9. Laws relative to the energy sector

Among the texts relative to the electricity sector relevant to the project, we can cite:

- ⇨ **Law n°98-29 of 14 April 1998** relevant to the electricity sector;
- ⇨ **Law n °2002-01** abolishing and replacing the article 19, paragraphs 4 and 5, and the chapter IV of the law n°98-29 of 14 April 1998 relevant to the electricity sector.

In the framework of this project, the operator must hold a production license before the start-off of the power plant activities and respect all these engagements with the Ministry of the Energy and Renewable Energies Development.

IV.2.1.10. TEXTS RELATIVE TO THE LAND

The lands of Senegal are divided in three (03) categories:

- the national domain is constituted of non-classified lands in the public domain, unregistered and which property is not transcribed in the land conservation;
- the State domain including the public domain and the private domain and enjoying all the real estate needs and rights of the State;
- the domain of individuals including the land registered in the name of individuals.

These lands are governed by a land legislation through various texts of which the most relevant for this project are:

- The Law n° 64-46 of 17 June 1964 relative to the national domain;
- The decree n°64-573 of 30 July 1964 fixing the application conditions of the law n°64-46 of 17 June relative to the national domain;
- The decree n°72-1288 relative to the allocation and deallocation conditions of lands of national domain;
- The Law n° 76-66 of 2 July 1976 concerning the Code of the State domain;
- The Law n° 76 – 67 of 02 July 1976 relative to the dispossession for a public purpose cause;
- The Law n° 2013-10 of 28 December 2013 named « Act III of the decentralization » concerning the general Code of Collectivities.

The Law n° 64-46 of 17 June 1964 relative to the national domain and its different application texts divide the lands of national domain into four areas: the pioneer areas, the urban areas, the terroir areas, and the classified areas that are protected spaces.

The lands requested by this project are issued in the national domain belonging to the terroir area of Malicounda Commune. SENLEC has obtained from the rural council of Malicounda the deliberation n°02/CRM as of 27/01/2012. At this stage of the project, SENELEC is in contact with the administrative authorities and the local collectivities for the reestablishment of successful tenderer that was in the land base of the power plant. The character of public interest of the project justifies the delocalization of plot of the land towards another site. It is known, with the agreement of the mayor of Malicounda, that the tenderers of these lands are recast in another place appropriate for the site affected by the project. SENELEC interfere actively in in the realization of this solution without it, there will be no construction on the site. The mobilization of the Statistics Commission and the compensation payments for the PAP will be a decisive stage for the realization of the project.

SENELEC, who holds an extract of the plan that is a cadastral document done by the cadaster office, has made the securitization procedure. In fact, SENELEC has introduced a lease request for Mbour domains' office.

IV.2.1.11. TEXTS RELATIVE TO THE DECENTRALIZATION

The government of Senegal, in its development policy for the territories potentiality, has adopted in 2013 a new reform that preconize the suppression of regions as decentralized entities and their replacement by pole-territories through the intercommunity, the passage to the integral communalization, in other terms the erection of all the rural communities of Senegal.

In this context the law n°2013-10 of 28 December 2013 named « Act III of decentralization » concerning the general code of local collectivities abolish and replace the law n° 96-06 of 22 March 1996, modified, concerning the local collectivities code, the law n° 96-07 of 22 March 1996, concerning the transfer of competences to the regions, to the communes and the rural communities and the law n° 96-09 of 22 March 1996 fixing the financial and administrative organization of the commune of districts.

The transfer of competences of the local collectivities are described in the book II of this law. The power plant is implemented in the local collectivity of Malicounda.

IV.2.2. COMMUNITY JUDICIAL FRAMEWORK

Different texts relative to the energy and environment sector that were adopted in the community framework make part of the legal arsenal to be taken into consideration in the execution of the project. It consists of:

- The additional Act n°04-2001 of 19 December 2001 concerning the energetic policy of UEMOA;
- The Decision n°02/2009/CM/UEMOA of 27 March 2009 concerning the creation, organization and functioning of the regional committee;
- The Decision n°06/2009/CM/UEMOA of 25 September 2009 concerning the UEMOA strategy called Regional Initiative for sustainable Energy (IRED);
- The Decision n°07/2009/CM/UEMOA of 25 September 2009 concerning the modality of the implementation of the IRED described in the chapters II and III the financial and institutional provisions of IRED;
- The Law n°2006-15 of 30 June 2003 authorizing the President of the Republic to ratify the protocol of the CEDEAO A-P4-1-03 on the Energy, adopted at Dakar on the 21 January 2003;
- The Decision n°08/2009/CM/UEMOA of 25 September 2009 concerning the creation of Energy Development Funds (FDE);
- The Decision n° 02/2012/CM/UEMOA of 10 May 2012 concerning the creation, organization and functioning of the regional committee of producers, transporter and electrical energy distributors of the members of UEMOA.

IV.2.3. INTERNATIONAL JUDICIAL FRAMEWORK

- **Environmental and social procedures of the African Development Bank (AfDB)**

Version III, 2016 of the Equator Principles:

The environmental and social procedures of the AfDB refer to the 10 principles of the Equator (“Equator principles –EP”) in its III version of 2016 (EPIII). It consists of a set of provisions made for a healthy environmental and social problems management. By voluntary signing the Equator Principles (EP), the bank engages in taking into consideration a certain number of environmental and social evaluation criteria when choosing projects, it will fund. We can consider these principles as an application of the CSR in the domain of finance. These AfDB Environmental Norms have not been the subject of a Convention nor a signed agreement with the Senegalese State. Hence, they will be respected by all the clients of the Bank when having a fund for a project that will affect the site environment. The Integrated Backups System (SSI) is divided into five (05) Operational Safeguards:

- **Operational Safeguard N^0 1:** Environmental and Social Assessment
- **Operational Safeguard N^0 2:** Involuntary Resettlement, land acquisition, population displacement and compensation.
- **Operational Safeguard N^0** 3: Biodiversity, renewable resources and ecosystem services
- **Operational Safeguard N^0** 4: Pollution prevention and control, greenhouse gas, hazardous materials and resource efficiency.
- **Operational Safeguard N^0 5:** Labor conditions, health and safety.

Other norms and relevant guidelines remain applicable once they are launched within the SSI framework. Mainly consisting of:

- Bank Gender Policy (2001);
- Civil Society Engagement Framework (2012);
- Dissemination and Data Access Policy (2012);

- Handbook for Consultation and stakeholders' participation in the Bank activities (2001);
- Bank Policy related to population and implementation strategies (2002);
- Environmental and Social Evaluation Procedures for the Bank activities (2015).

Table 27: **AfDB Operational Safeguards**

Operational Safeguard (OS) of AfDB	Application to the Project
• OS N^0 1: Environmental and Social Evaluation • This OS governs the process of environmental and social category determination of the project, and thereunder the environmental and social evaluation conditions.	• This Operational Safeguard updates and consolidates the engagement policies outlined in the environmental policy of the Bank. This OS is applicable to the project in whole. • The project of power plant construction in Malicounda requires a certain environmental and social evaluation level adapted to the potential risk significance, in a way that allows to the borrower to prepare and implement an ESMP in the case of this investment project. • This comprehensive ESIA was defined as class A and confirmed by the Directorate of the Environment and the Classified Establishments (DEEC) of the Ministry of Environment and Sustainable Development of Senegal in its validation letter for the terms of reference of ESIA (addressed to the Quality, Security and Environment Director of SENELEC) n^0 181 of the 15^{th} of January 2018/MEDD/DEEC/DEIE and its annex on the detailed axes of the ESIA expected report.
• OS $N^0$2: Involuntary resettlement, land acquisition, population displacement and compensation • This OS $N^0$2 consolidates the engagements and political conditions set forth in the AfDB policy on the involuntary resettlement and incorporates a certain number of enhancements willing to increase the operational efficiency of these conditions.	• In accordance with the OS 2 of the AfDb Bank, the promoter must ensure a fair and equitable compensation for the PAP who lost their lands with the emergence of the project and the resettlement that enhance the lifestyle and the global livelihood means. In this study, it is highlighted that SENELEC ensures the OS respect and pays the compensations to the concerned persons through the PAR which is in progress. • For the PAR preparation of the Malicounda Power Plant, the consultant refers to the documents of this OS 2. The OS 2 constitutes the main reference for the PAR elaboration and has three (03) main objectives: 4. The minimization of the resettlement while studying all the alternatives in the project conception (security distance of 260 m circumscribed on the land of 18 ha of the power plant site). 5. When a displacement is inevitable with goods loss, the resettlement activities must be conceived under a program in order to allow to the affected persons to benefit from the project. In addition, these persons must be consulted in a way to participate in the planning and the implementation of the resettlement, compensation and livelihood means restoration program. 6. The affected persons must find a higher or equal lifestyle to the one they had before their displacement

OS N°3: Biodiversity and ecosystem services. The most important objective of this OS is to conserve the biological diversity and to promote the sustainable use of natural resources. Mainly the water resource in respect of the United Nations Convention on the biological diversity. The OS sheds the light on the necessity of Respect, conserve and maintain [the] knowledge, innovations and practices of the native and local collectivities etc. [and] to protect and foster the use of biological resources according to the cultural traditional practices compatible with the conservation or sustainable use requirements of the natural resources.	The OS 3 guidelines are applied to the project whose promoter has legal, judicial, regulatory and development standards cited in the report of ESIA. Plant species, small mammals and reptiles can be very sensitive towards certain pollutants. Furthermore, a risk of a small fauna drops (small reptiles or rodents) in the open excavations can be noted during the power plant construction works and could lead to the disappearance or the degradation of the vegetation and a temporary micro fauna perturbation. Hence, the site is highly marked by the human presence with the inauspicious cultural practices to the conservation of the natural vegetation. The OS 3 recommends conserving the biological biodiversity and promoting the sustainable use of natural resources. In order to minimize the potential impacts on the fauna and the flora, the enterprise in charge implements written recommendations to the section VIII.3.
OS N°4: Pollution prevention and control, Greenhouse gas, hazardous substances and efficient resources use This OS 4 covers the whole pollutions, waste and hazardous substances effects range for which there are international conventions and special industry complete norms that are applicable by other MBD. It also introduces a vulnerability follow up analysis framework for the greenhouse gas emissions levels and offers a detailed analysis for the possible decrease or compensatory measures.	The OS 4 guidelines are applicable to the project. In fact, the power plant functioning will provoke pollutants and dust emissions (like Sox, NOx, PM10, PM2.5 and CO) and to a lesser extent, volatile organic compounds (VOC) and aromatic polyclinic hydrocarbons (PAH). The concentration in SOx, NOx, PM10, PM2.5 modeled with NUMTECH, respect the threshold values of the Senegalese repositories and the international standards except the second interim target of the WHO 125 µg/m3 is exceeded on a limited area (sectionVIII.3.1.2.1). It is important to add to these results that the power plant is conceived to move to the gas by the year 2021. As a result, a stack altitude of 42 m was judged enough in the frame of this study and allows to respect the regulatory limits and theOS4. The power plant operator has to limit the waste production (non-hazardous and hazardous) but also recuperate and reuse the waste ecologically according to theOS4 principles. The promoter has to control these GHG emissions according to the signed agreement in Paris in 2015 while observing the respect of the Senegal Engagement to GHG emissions reduction for the Senegal by the year 2035, during the Paris Agreement on the climate in 2015. The main attenuation proposed measures are: • Ensuring a NOx, SO_2 and PM atmospheric emissions follow up on the stacks and provide particular and molecular filters in the stacks; • Insure the use of a sulfur-based fuel (less than 2%).

	As for the water supply, it will be insured by the borehole (6 m3/h). The hydrogeological study done by the operator allowed to ensure the resource availability and the possibility of implementing this borehole without major consequences. However, during the construction and operation works, water will be rationally used according to the OS 3, in order to preserve the resource and not compete people water supply. The main attenuation proposed measures are: • Proceed to the desulfurization of combustion gas and use low-carbon torch NOx; • Create green spaces for the environment protection and the people lifestyle quality, but also promote the CO2 photosynthesis absorption, main greenhouse gas. A management procedure for hazardous substances will be also developed during the operation phase in order to establish manipulation and storage methods, and security work techniques.
OS N°5: Work, health and security conditions This OS 5 defines the AfDB requirements towards its borrowers or clients, related to labors work conditions, their rights and protection from mistreatment or abuse.	In conformity with OS 5, the operator and the enterprises have to elaborate a human resource policy as well as nature procedures, the project size and the labor force size. They must also guarantee to their employees a healthy and secure work environment. In the event of recourse to an expatriate employee, the operator has to abide to theOS5 of the AfDB and the migrant employees must be treated in conformity with the local laws and benefit from the same work conditions as the non-migrant employees doing the same work. The promoter provides an internal human resources management policy outlined in the section VII.8.2 and according to the in force Labor Code and the OS 5 requirements. It will focus on the following aspects: • The prerequisites before the startup of any activity (enterprise establishment declaration and labors movements records declaration and IRTSS contracts types records; • Human resources policy and procedures with an internal reregulation valid by the labor inspector (schedule, behavior, security measures), communicated and accessible to all the enterprises employees; • Work conditions (respect of the collective conventions of electricity, work conditions enhancement through the hygiene, health and security respect); • Terms of employment and chance equal opportunities and sex. This human resource management policy, proposed to the project enterprise in the ESIA framework must necessary be communicated and understood by the staff and people.

Conventions and agreement ratified by Senegal

The table below is a summary of the conventions and agreements ratified by Senegal relevant to this project.

Table 28 : Conventions and agreements ratified by Senegal relevant to the project

Text, domain and objectives	Application Framework
Management of natural resources and fauna	
The convention on the wildlife and natural environment conservation, adopted at Berne on the 19 September 1979 aims to ensure the conservation of the flora and wild fauna and their natural habitat, otherwise, the particular attention is given to species, including the vulnerable and threatened migratory species.	The project has to ensure the biodiversity backup.
The **African convention on the nature and natural resources conservation, Maputo (Mozambique), 11 July 2003 and that of Alger in 1968** aim to enhance the environment protection, promote the conservation and the use of natural sustainable resources, harmonize and coordinate the policies in these domains in order to set up development policies and programs that are eco-friendly and socially acceptable.	The project has to be in line with the sustainable development principles.
The African **Charter on Human and people's rights, adopted in Nairobi on the 23 of September 1981, to its article** 24 dedicates the people's rights to a global and satisfactory environment suitable for their development.	The project has to respect the right of the population to live in a healthy environment.
The **ILO convention on the security, hygiene and health:** • Convention n°18 on the professional diseases of 10 June 1925; • Convention n° 155 of ILO on the employee's security and health; • Convention n°158 on the dismissal adopted in 22 June 1982; • Convention n°161 on the health services at work of 25 June 1985; • Convention n°187 on the promotional frame for the security and health at work of 15 June 2006.	Ratified by the government and hence relevant to the project.
The United Nations Sustainable Development Goals The 17 sustainable development goals and their 169 targets are listed in the extensions of the objectives of the Millenary for development. They aim to realize the human rights for all the people, the gender equality and women and daughter independence. Integrated and inseparable, they combine the three dimensions of sustainable development: economic, social and environmental. To this end, the SDG 7,9,12,13 and 15 are applicable to the project:	

• ODD 7. Guarantee the access of all to reliable, sustainable and modern and affordable energetic services; • ODD 9. Building a resilient infrastructure, promote a sustainable industrialization that helps all the persons and encourage the innovation; • ODD 12. Establishing consumption and sustainable production methods; • ODD 13. Take urgency measures to combat the climatic changes and their consequences; • ODD 15. Preserve and restore the land ecosystems, by using them in a sustainable way, manage the forest, combat desertification, end the biodiversity impoverishment.	
The international Convention to combat desertification in the countries seriously affected by the dryness and/or the desertification, particularly in Africa, signed in Paris on the 14th of June 1994.	The premises release will require a land clearance. Then, the operator has to set up adequate compensation measures.
The convention concerning the world cultural and natural heritage adopted in Paris on the 16th of November 1972 defines the conditions of the protection of the cultural heritage.	The site is not a cultural heritage but in in case of archeological remains, the national procedure has to be followed up.

IV.2.4. INSTITUTIONAL FRAMEWORK

The institutional framework aims at identifying certain structures and evaluate their capacity to manage adequately the environmental and social aspects and when needed, to identify the reinforcement of capacities required in the implementation of the project.

The social and environmental management of the project will include various institutions, local and regional national structures and will be ensures at three (03) levels:

- On the national level: through DEEC, the Technical National Committee and the other administrations and technical services included in the management project;
- On the regional level through the Regional Committee of Environmental Monitoring;
- On the local collectivities level (sub-prefect, Mayor, municipal councils etc.).

The different institutions that must interfere in this project as well as their tasks are presented in the following table.

Table 29 : Institutions involved in the implementation of the project

Institution	Domain of application
The Ministry of Energy and Renewable Energies Development prepares and implements the policy in terms of production, distribution and promotion of the energy. The Ministry of Energy through the different structures it composes, defines and executes all the program of restructuration of the energy sector in Senegal.	The Ministry has to grant an electricity production license to the operator for the construction and the operation of the thermal power plant of 120 MW.
The Directorate of electricity is responsible for other tasks: • Preparing and following up the execution of the development plans and programs in terms of energy; • Planning and following up the rural and urban electrification development works with the concerned institutions; • Following up with the Commission of regulation of the electricity sector, the execution of the management contracts.	This electricity production project answers the intervention policies and strategies of the Directorate of electricity.
SENELEC is tenderer of production. Transportation, distribution of electrical energy and also in charge of the funding identification and the realization of new installations in the intervention areas It has alone the right to exercise the purchase, transportation, retail of the electrical energy all over the territory. Hence, it holds the responsibility of production development by means of new installations that are required for the project.	SENELEC is in this contract the signatory of the energy purchaser according to the guidelines of purchasing to the clients fixed by the Regional Commission of the energy Sector (CRSE).
CRSE was created by the law n° 98-29 of 29 April 1998 relative to the electricity sector and organized by the decree n° 98-333 of 21 April 1998. In terms of the article 4 of the law, the Commission, composed of three persons, is an administrative authority responsible for the regulation of the production, transportation, distribution and purchase of energy, in conformity with the provisions of the current law. It instructs every license request or concession and forms its opinion to the Ministry in charge of the electricity for the decision.	For this project, this commission participates in the process of production license attribution.
The Ministry of the Economy, Finance and Planning (MEFP) is charged to approve every project of the macroeconomic framework defined in the PODES and the SRP, mainly. Being the only State budget delegate, the MEEP is responsible for the negotiation with partners concerning the development, project budget inscription and its financial execution through the general guidelines such as, The General Directorate of Taxation and Domains (DGID), General Directorate of the Public Accountability and Treasury (DGCPT), General Directorate of Finance (DGF) and the General Directorate of Planning (DGP).	The MEFP participates in this project as an approving delegate of the State and to provide the State guarantees and various exonerations, etc. The ministry has initiated the decree concerning the public utility of this project.
The **Directorate of the Environment and the Classified Establishments (DEEC)** plays an important role in the implementation of the policy of the Senegalese government, in terms of development. In order to implement the environmental policy of the State, the DEEC has the mission of: • prevention and control of the pollutants and nuisances;	The DEEC ensures that every project in the Senegal respects all the procedures starting from the beginning of the project until the conformity certificate issuance.

• follow up the actions of various services and organisms interfering in the environmental field; • elaboration of legal texts concerning the environment. The DEEC holds also regional services to ensure the follow up of proximity of environmental questions (the Regional Divisions of the Environment and the Classified Establishments (DREEC).	
Directorate of the Urbanism and of Architecture (DUA) is charged of the elaboration and implementation of the urban management tools: the studies, the conception and the implementations of plans and urbanism schemes (Guiding Urbanism Plan, Urbanism Detail Plan), the plans of urban displacements and of allotments, the elaboration of urbanism and architecture regulations, the implementation and the follow up of the restructuration policy.	The DUA through its regional and departmental services verifies if the project is not in a non aedificandi area.
The Directorate General of Labor and Social Security (DGTSS) is in charge, among other things, of ensuring the special protection of workers employed by temporary work companies and the obligations to which these companies are subject to, in the interest of the worker in temporary or mobile construction sites where building work is carried out or civil engineering works that constitute the workplaces where the greatest number of accidents at work are recorded. Within the framework of the project, the DGTSS of Dakar intervenes in the verification of the conformity of work in construction sites (working hours, basic salaries, ages, etc.).	In the framework of this project, the DGTSS of Dakar verifies the respect of the work conditions.
Regional Development Agency (1), through law n° 2013-10 of 28 of December 2013 for the General Code of the local Collectivities, gives the opportunity to the local collectivities (communes and districts) of the same circumscription, administrative region to create a common agency called the regional Agency of Development (ARD) with a general mission to encourage the coordination and the harmonization of the initiatives and interventions of the local collectivities in terms of local development.	The ARD helps the local collectivities to develop through the projects such as the Malicounda power plant project.
The National Agency for Spatial Planning (ANAT) was created by the decree n° 2009-1302 of 20 November 2009 and has the statute of a moral person with a public right. It is part of the Ministry of Spatial Planning and Local Collectivities. The ANAT has as mission to promote and implement the governmental policy in terms of spatial planning, geographical works and enhancement of life level of the populations.	The ANAT participates in the enhancement of the population's life.
The Control Commission of Domanial Operations (CCOD) It is listed in the article 55 of the Code of the State domain. The CCOD gives its opinion mainly on the land questions.	The CCOD gives its opinion on the land questions.

In summary, the application of these decisions, regulations, laws and conventions, will allow to optimize the environmental management of the project of the electrical Malicounda Power Plant. Therefore, the promoter has to integrate these factors during the construction and operation phases in order to conform to the national, sub-regional and international legislation, mainly to conform with the policy of the Senegal government especially the Emerging Senegal Plan (ESP).

V. DESCRIPTION OF INITIAL ENVIRONMENT

V.1. GEOGRAPHIC, ADMINISTRATIVE SITUATION AND LOCALIZATION OF THE POWER PLANT SITE

The selected site for the thermal power plant construction and operation project is located in the Commune of Malicounda, Mbour district, Region of Thies.

Situated at the west of Senegal, the region of Thies extends to the surface of 6 670 km^2 or 3,4% of the national territory, for a population estimated at 1 995 037 habitants or 13,2% of the population of the country (ANSD projection, 2017). The Region of Thies is bordered:

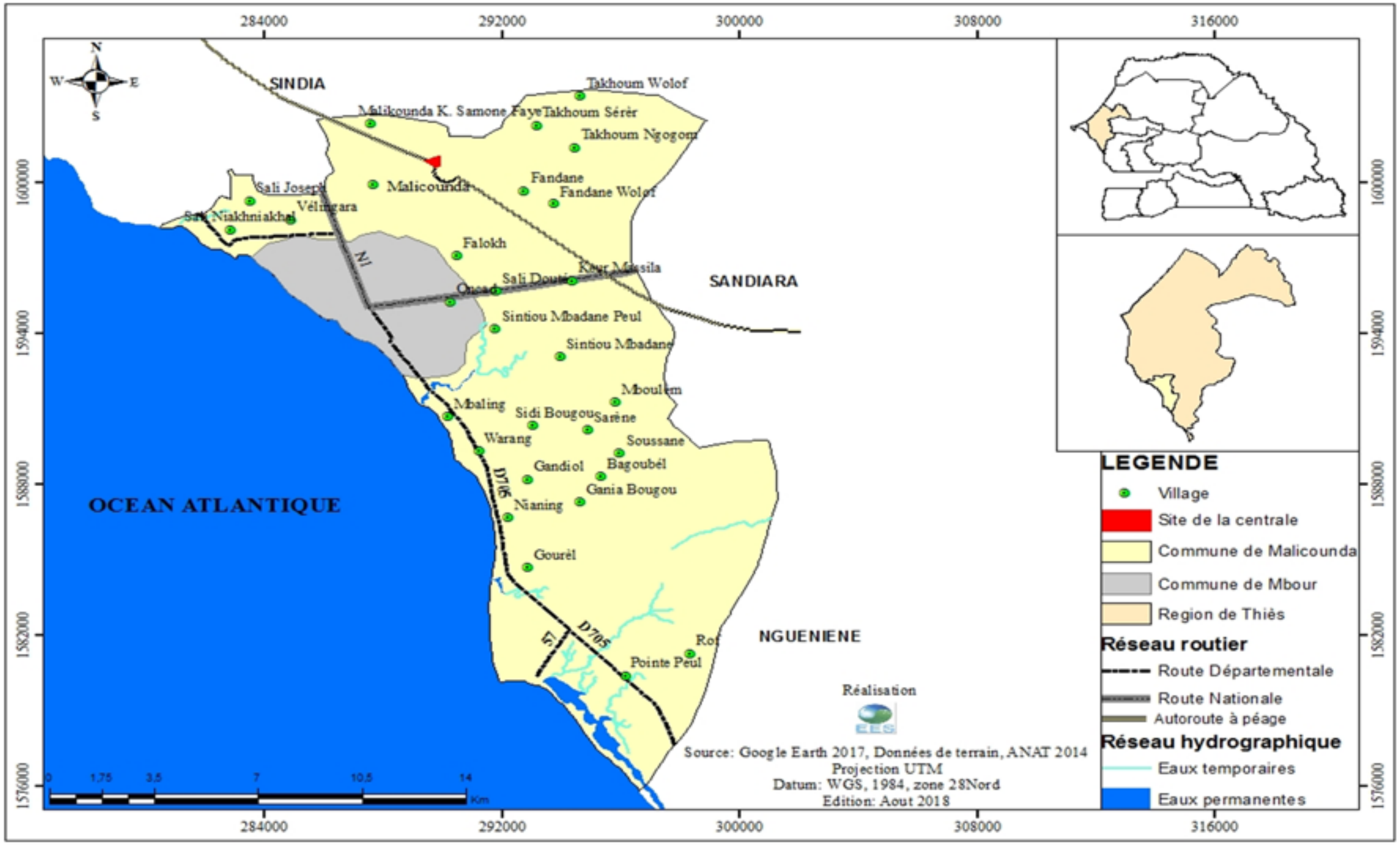
- to the north the region of Louga;
- to the south the region of Fatick;
- to the west the region of Dakar and the Atlantic Ocean;
- to the west the regions of Diourbel and Fatick.

The power plant will be implemented in the village of de Keur Maissa Faye (Malicounda Wolof), Commune of Malicounda. Malicounda was formed according to law N°72-25 of 25 April 1972 instituting the rural communities in Senegal. However, with the arrival of the « Act III of the decentralization », it was erected in a commune.

Situated at the south-west of Thies region, this commune covers a surface of 124 km^2 and counts 22 villages (PDC[3]). It has also a coastline on the Senegalese littoral. The commune is bordered:

- to the north by the Commune of Sindia;
- to the east by the Communes of Sandiara and Nguieniene;
- to the south-east by the Commune of Nguieniene;
- to the west and south-west by the Atlantic Ocean.

[3] Communal development plan of Malicounda



Map 3 : Localization of the power plant site in the commune of Malicounda
Legend: Village/Site of the power plant/Commune of Malicounda/Commune of Mbour/Region of Thiès/Road network/ Secondary road/Highway/Toll road/Hydrographic network/Temporary waters/ Permanent waters

V.2. LOCALIZATION OF THE POWER PLANT SITE

The power plant site is situated at the west of the village of Keur Maissa Faye, to the north (about 55 m) of the road linking the national road N1 to Malicounda. The site is bordered:

- To the north by rainfall cultivation fields and few buildings under construction;
- To the east by the village of Keur Maissa, Faye (Malicounda Wolof) an orchard and rainfall cultivation fields;
- To the south by an allotment, houses and a paved road;
- To the west by a toll highway and rainfall cultivation fields.

V.3. SITE ACCESSIBILITY ON THE NATIONAL LEVEL

To rally the Malicounda Power Plant, they must borrow the national road N1 until Malicounda to follow then the paved road that leads to Keur Maissa Faye (Malicounda Wolof) (cf. map 1). The site is situated at 60 m of this road, at the entrance of the village of Keur Maissa Faye.

V.4. LAND LOCALIZATION AND OCCUPATION OF REGIONS OF INFLUENCE

V.4.1. LOCALIZATION OF REGIONS OF INFLUENCE

The influence area corresponds to the space where potential accidents (dust, noise, discharges in the natural environments, etc.) could be noticed.

It is function of the nature of the project and the natural environments (fauna houses, flora, etc.) and human surroundings where the project could be influenced.

In function of the potential impact sources resulting from the project, two (02) influence areas can be identified.

V.4.1.1. DIRECT INFLUENCE AREA

The direct influence area is the area that includes the realization and operation works of the thermal power plant. It covers a surface of 18 ha and corresponds to the space where the project is technically achievable (direct premises).

V.4.1.2. EXTENDED INFLUENCE AREA

It is similar to the surrounding streets, cities and villages, to the establishments and activities adjoining the power plant. It includes also the road axes used by the trucks for the transportation of construction material.

This influence area is divided into near and far areas of study. The extension of these areas is defined according to their physical, human, or biological concerned components.

- **Near area of study**

It corresponds to the immediate environment of the site. The biological environment includes in the area of study can be circumscribed in the 500 m around the area of the premises. This radius allows to take into account the ecological interest potentially present at a proximity of the site.

The human environment identifiable in the near area of study is circumscribed at the level of the directly concerned populations that are mainly the villages of Keur Maissa Faye, Darou Thioubène, Malicounda Ngueurigne, Keur Masseib Mbengue, Nioukhoub and Malicounda Bambara.

- **Far area of study**

The physical environment, included in the far area of study, is defined by the specialties of each studied parameter. Then, the hydrography, climate and the geology are presented in a large scale covering the normal variations of each parameter and in function with the nearest available data to the area of the project.

The biological environment extends over 1 km of the area. This circumscribed radius allows to take into consideration the homogeneity/biological specialties to a macroscopic scale.

The human environment extends over the scale of the Arrondissement of Keur Moussa, of the district of Mbour and also to the region of Thies and the country in function of thematic. The public consultations follow also this scheme.

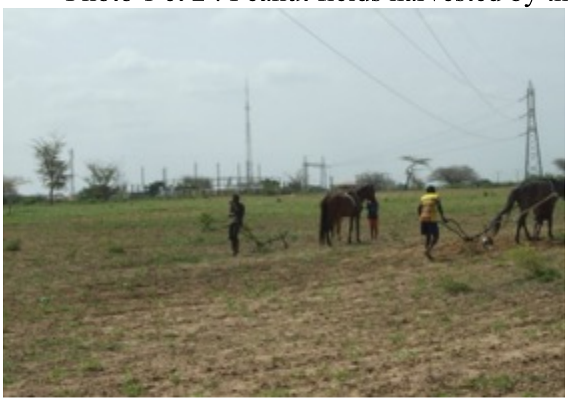
V.4.2. Land Occupation of regions of influence

V.4.2.1. Direct influence area or site premises

Relative to the site premises, this area extends over the 18 ha that were deliberated by Malicounda municipal council at SENELEC expecting the construction and operation of a thermal power plant on about 06 ha.

Cultural lands. In fact, the site is used by the local populations practicing the rainfall cultivations such as peanut, millet and cow peas. The fields are sprinkled with *Mangifera indica* (manguo tree), *Prosopis juliflora*, *Guiera senegalensis* (Nguer), *Combretum glutinosum*. Two (02) vegetable species partially protected were identified on the site. They are *Andansonia digitata* (Baobab) and *Faidherbia albida* (Kadd).

Photo 1 et 2 : Peanut fields harvested by the local community at the power plant site




Source : EES, August 2017

V.4.2.2. Extended influence area

This area near the site

This area corresponds to the immediate environment of the power plant site.

- **Northern border**

The site is bordered to the north by two (02) buildings under construction, a well and rainfall cultivation field. A graveyard was identified at approximately 100 m of this northern border.

Photo 3 et 4 : Buildings under construction on the northern border of the power plant

Source : EES, August 2017

Photo 5 : Graveyard situated north of the power plant

Source : EES, August 2017

- **South border**

The southern border of the site is composed of allotments, buildings under construction, first houses of the village of Keur Maissa Faye (Malicounda Wolof), a sandy track and a paved road.

Photo 6 et 7 : Sandy lead and paved road situated on the south border of the power plant site

Source : EES, August 2017

- **East border**

The site is bordered to the east by the first houses of the village of Keur Maissa Faye (Malicounda Wolof), an orchard, rainfall cultivation fields and a building under construction.

Photo 8 : First houses situated in the east of the site

Source : EES, August 2017

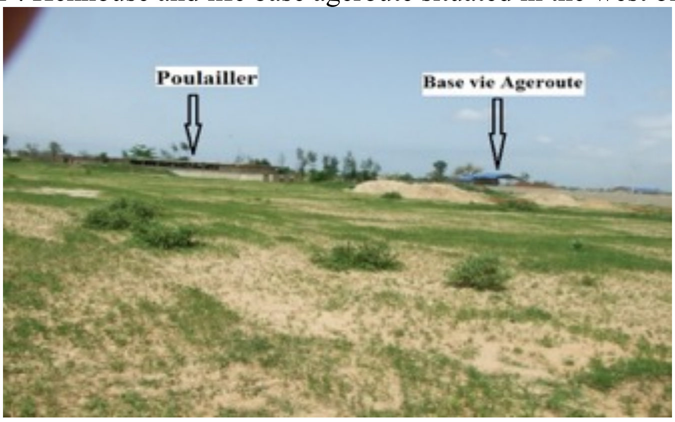
Photo 9 et 10 : Buildings under construction situated in the east of the power plant

Source : EES, August 2017

- **West border**

The site is bordered to the west by a rainfall cultures field and a toll highway (40 m). Above this border, there is a henhouse at 148 m and the life base of the Concessionaires Ageroute at 124 m.

Photo 11 : Henhouse and life base ageroute situated in the west of the site

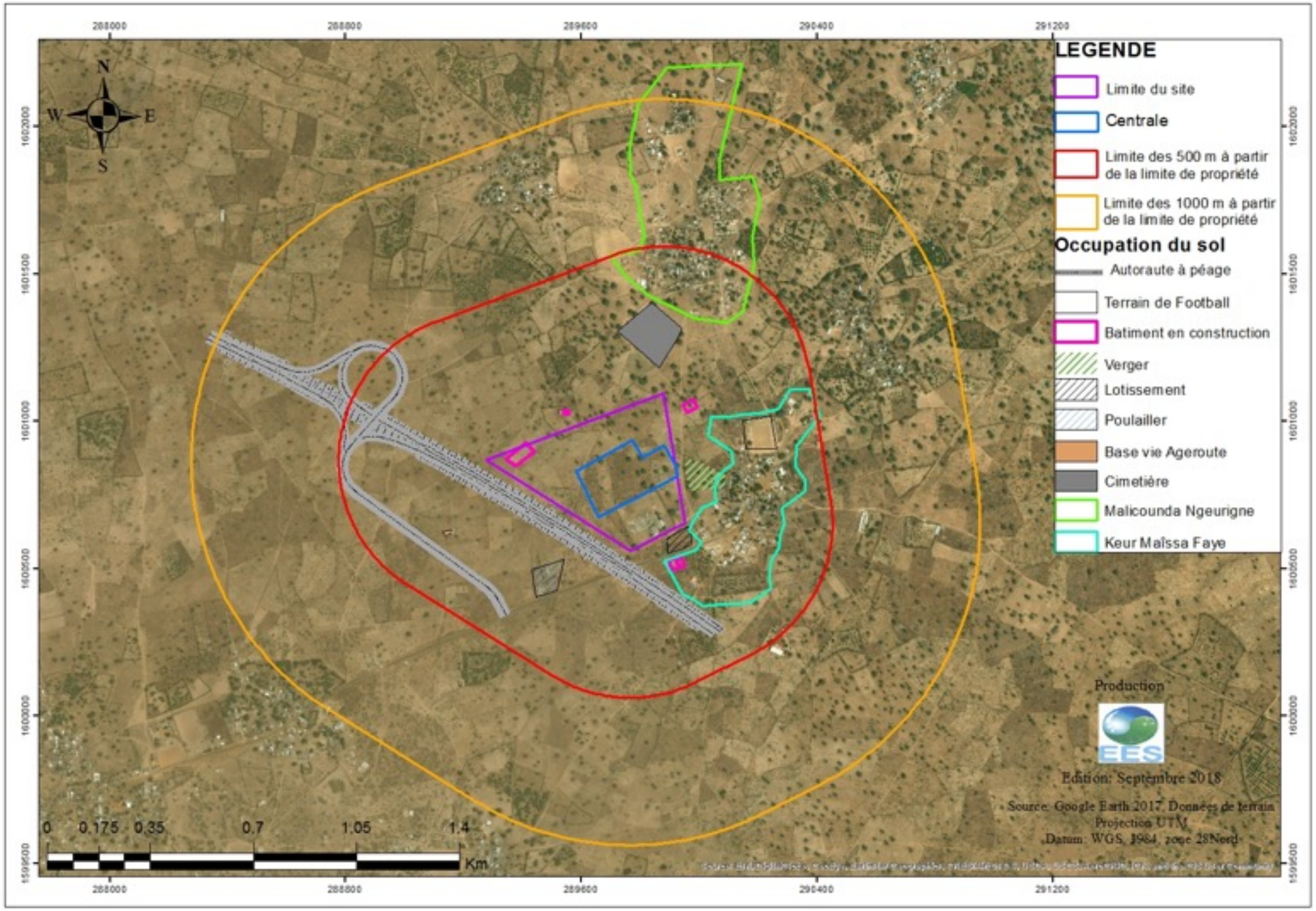


Source : EES, August 2017

The table below summarizes the different entities identified in the immediate environment of the site.

Table 30 : Immediate surroundings of the site

Entities	Distance relative to the power plant site	Distance relative to the border of the future power plant	Orientation relative to the power plant site
Building under construction	Crossed by the power plant border	82 m	North
Building under construction	82 m	241 m	
Cement industry	101 m	170 m	
Malicounda Ngueurigne	256 m	362 m	
Orchard	14 m	40 m	East
Houses (K. Maissa Faye)	40 m	150 m	
Building under construction	18 m	115 m	
Toll highway	40 m	118 m	West
Life base Ageroute	124 m	219 m	
Henhouse	148 m	219 m	
Paved road	55 m	233 m	South
Allotment	20 m	195 m	
Houses (K. Maissa Faye)	39 m	164 m	



Map 4 : Land use of the power plant site

<u>Legend</u>: Limit of the site/power plant/500 m limit from property boundaries/1000 m limit from property boundaries/Land occupation/Toll road/ Football playground/Under construction building/Orchard/Housing estate/Hen house/Life base of Ageroute/Cement industry/Malicounda Ngeurigne/Keur Maissa Faye

V.5. DESCRIPTION OF THE PHYSICAL ENVIRONMENT

V.5.1. RELIEF AND TOPOGRAPHY

The relief is flat as a whole with however few sand dunes all along the coastal fringes.

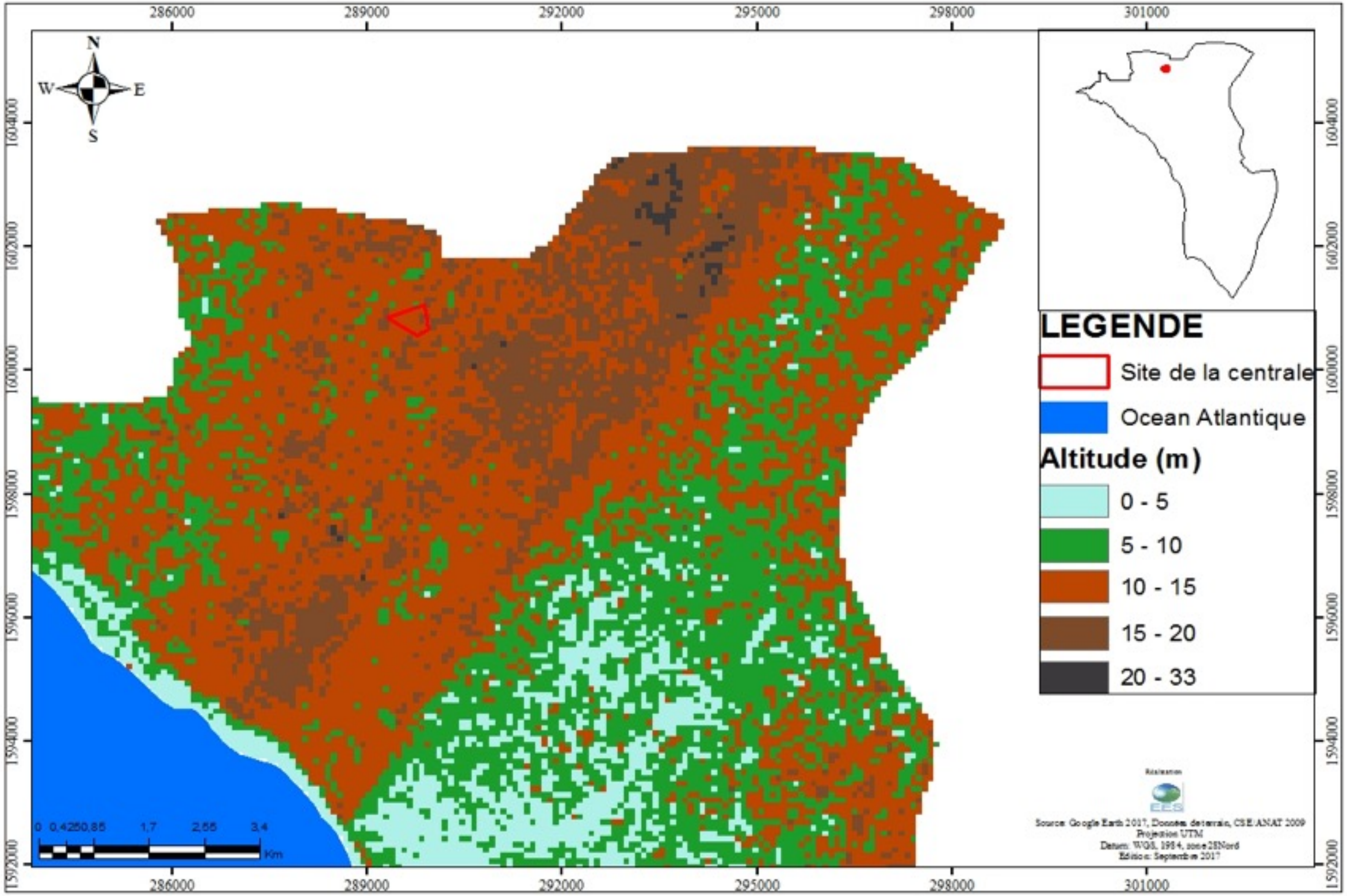
The relief of the commune of Malicounda, hosting area of the project, is in general relatively flat, with few sand dunes all along the coastal fringes as well as valley bottoms at the north-east and south. The altitudes vary between 00 and 33 m, to the west in the east. In fact, the most important altitudes can be found in the north-east and south-east of the commune. At the power plant site, the altitudes fall between 10 m and 15 m.

V.5.2.GEOLOGY

The Commune of Malicounda is situated in the Senegalo-Mauritian settling tank where the repositories of the Secondary and the Tertiary are crammed. The Tertiary formations known to the outcrops in the area of the project are:

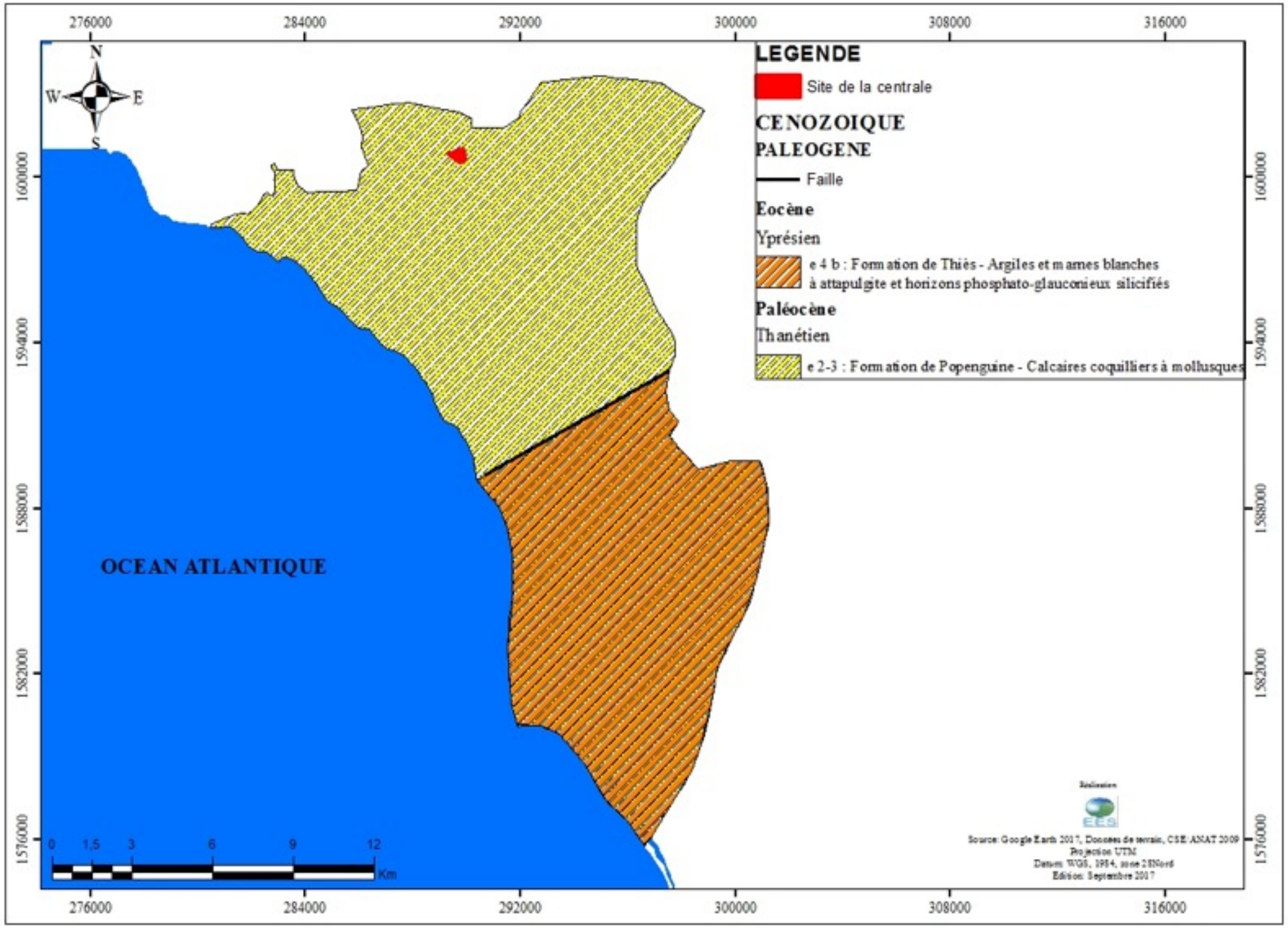
- **Ypresian**, facies recorded in the inferior Eocen where the outcrops are built from claystone and white sheetlet marnes attapulgites and horizontal silicified (Thies formation). This Outcrop formation is in the southern part of the commune.
- **Selandian-Thanetian**, age of Paleocene where the outcrops are composed of the mollusic shells (Popenguine formation). This layer outcrops on the northern part of the commune.

The power plant will be installed on the tropical ferruginous repositories where the base is composed of calcareous mollusic shells.



Map 5 : Topography of the project area

Legend: Site of the power plant/Atlantic ocean/Altitude/0-5/5-10/10-15/15-20/20-30.



Map 6 : Geological formations of the project area

Legend: Site of the power plant/ Cenozoic Paleogene/ Flow/Eocene/ Ypresian/e 4 b: forming of Thies- Clay and white marls with attapulgites and horizontal silicified phosphate-green sand/Paleocene/ Thanetian/ e 2-3: Forming of Popenguine/Calcareous mollusic shellfish

V.5.3. WATER RESOURCES

V.5.3.1. UNDERGROUND WATERS

In the Malicounda community, the aquifers mined by drilling are those of Maastrichtian and Paleocene. As for groundwater, it is exploited by traditional wells.

V.5.3.1.1. Deep aquifer system (Maastrichtian)

It is the deepest and most important in the entire Senegalese sedimentary basin. It covers the only sandy to sandy-clayey or sandstone formation of the Maastrichtian (MA). It includes an upper aquifer layer of high power fresh water (300 to 400 m) surmounting a layer of fossil saltwater.

The substrate and the northern and southern limits of the system are not precisely known. Its depth varies between 200 m and 250 m.

In the municipality of Malicounda, the Maastrichtian aquifer is captured by the drilling of Malicounda Wolof (237 m) and Malicounda Sérère (222.45 m) [4]. Due to its depth, the aquifer is better protected against pollution.

V.5.3.1.2. Intermediate aquifer system (Paleocene)

It regroups the mostly limestone, karstic and marl-limestone formations of Eocene (EO) and Paleocene (PA).

The Paleocene aquifer mainly consists of limestones, marls, and marly limestones. It is in hydraulic continuity in its upper part with the water table of the Continental Terminal in the project area.

This aquifer system is in contact with marine waters along the coast. Thus, it is widely invaded by saltwater to the west and along the Somone River (Somone-Bandia Axis)[5].

V.5.3.1.3. Groundwater

The groundwater in the clay sands with lateritic clays of the continental terminal is located at shallow depth. It is captured by wells between 10 and 30 m and the water quality is good. This aquifer experiences marine invasions as per location. It recharges during the rainy zone and experiences a fairly remarkable drop during the dry season.

Moreover, facilities allow water to be stored in basins from November to June where the populations practice market gardening on 27 and 40 ha[6] respectively.

In summary, the Municipality of Malicounda has three (03) boreholes in service and one (01) borehole under construction. The boreholes closest to the plant site are the Malicounda Wolof and Malicounda Bambara boreholes.

[4] Regional Division of Hydraulics of Thies.

[5] Regional Division of Hydraulics of Thies.

[6] Malicounda Communal Development Plan

Table 31 : Some characteristics of the Malicounda Wolof and the Malicounda Bambara boreholes

Locations	Depth (m)	Initial Pumping rate (m^3/h)	Current Pumping rate (2017) (m^3/h)	Captured waters	Dry residue (mg/l)
Malicounda Bambara	222.45	50	36	Maestrichtian	462
Malicounda Wolof	237	23,5	15		X

Source : ASUFOR Malicounda, 2017

V.5.3.1.4. Quality of underground waters

For the chemical quality of the Paleocene and Maastrichtian aquifers, hydrogeological studies (BRGM 1998 and SAFEGE 1993), geo-electric prospecting carried out by MERLIN (2011), SAFEC (2015) as well as drilling carried out in the Somone and Mbour sectors in 2013 show that in the Somone / Mbour / Gandigal / Nguékokh zone, the water table Paleocene is generally salty while that of Maastrichtian is sweet except for enclaves located in the North-East where it is salted as well as in the east of Mbour.7

V.5.3.2. SURFACE WATERS

There are no waters in the Municipality of Malicounda. However, there are dead valleys at Mballing and Pointe Sarène, causing temporary ponds that recharge during the rainy season and dry up during the dry season. These ponds are mostly located in the center-west and south-west of the town.

Thus, located in the north of the town, the site of the power plant is not close to any permanent or temporary watercourse (see Map 1).

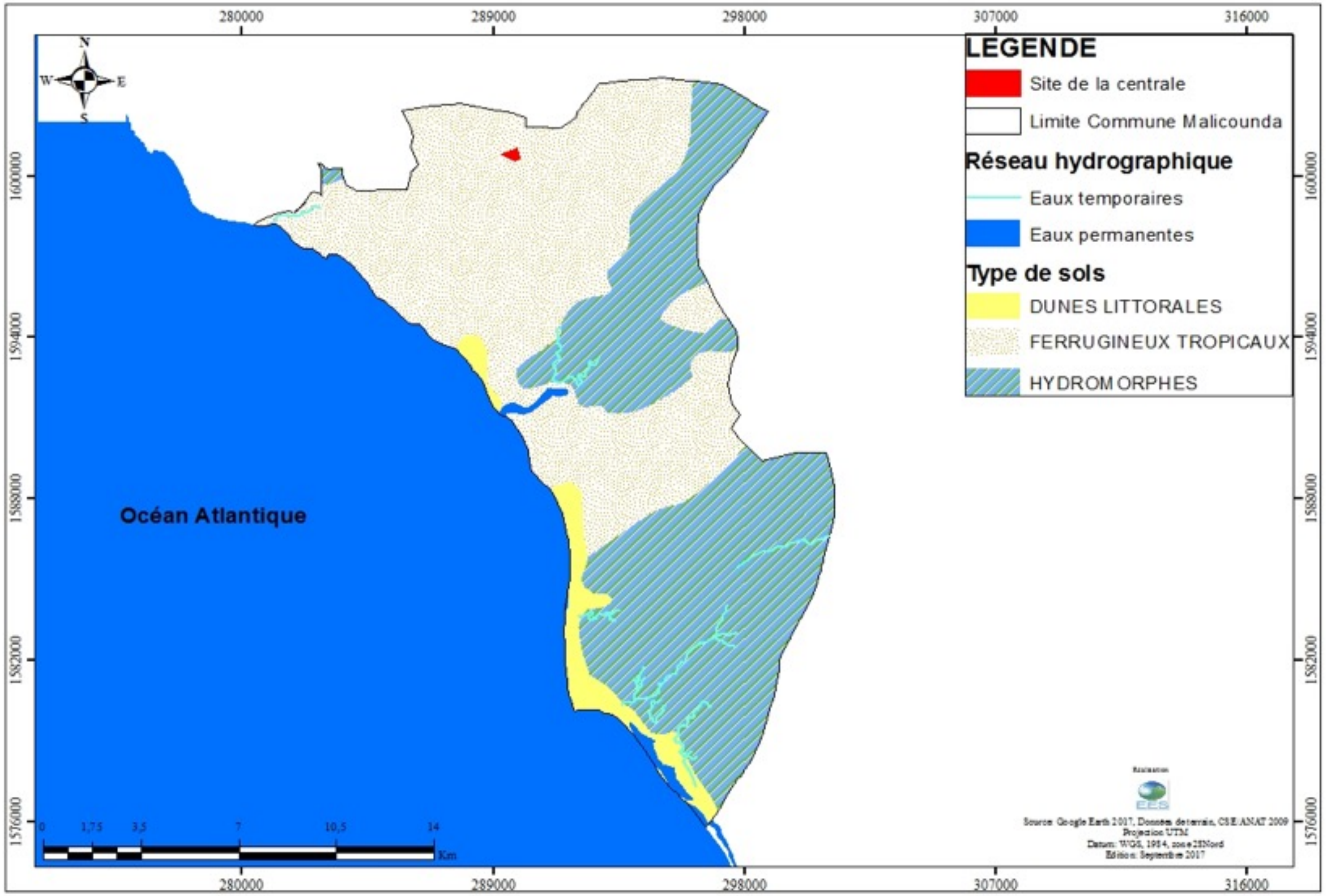
V.5.4.TYPES OF SOIL

In the Municipality of Malicounda, project area, the soils are characterized by a diversity of soil resources. Three (03) soil types are mostly known: coastal dunes, ferruginous tropical soils which are not leached or are slightly leached or "***Dior***" soils and hydromorphic soils or ***"Deck"*** soils.

The **plant site is located on tropical ferruginous soils that are not or only slightly leached.** These slightly deeper soils are well drained thanks to their sandy components.

However, their humus horizons are very exposed to wind and water erosion. They are poor in organic matter and are generally used for rain-fed agriculture and grazing.

[7] Regional Division of Hydraulics of Thiès



Map 7 : Types of soil of the project area

<u>Legend</u>: Site of the power plant/Limit of the commune of Malicounda/Hydrographical network/ Temporary waters/Permanent waters/Type of soil/Coastal dunes/Ferruginous tropical/Hydro morphs

V.5.5. CLIMATE

V.5.5.1. AIR QUALITY REFERENCE SITUATION

As part of this ESIA, particle and gaseous pollutant measurement campaigns were carried out in September 2017 by the Bio Tox Labs Group.

The aim of these measurement campaigns is to establish the baseline air quality situation at the village level that could potentially be impacted by the future Malicounda thermal power plant. The identified measurement points correspond to residential areas (Keur wally, Malicounda Ngueurigne, Keur Masseib Mbengue, Malicounda Bambara), ERP (Keur Maissa Faye school, Keur Darou mosque, health post), infrastructure (electrical substation, solar power plant, borehole).

Table 32: Localizing various measurement points

Localizing various measurement points of the ambient air in Malicounda			
N°	**Points of measure**	**Coordinates UTM**	
		X	**Y**
1	Electrical substation of Malicounda	289857	1600660
2	Keur Maissa Faye school	290333	1601054
3	Solar Malicounda Power Plant	290681	1600727
4	Keur Darou Thioubène mosque	290563	1601432
5	Keur wally	290845	1602185
6	Malicounda Ngueurigne	290050	1601634
7	Keur Masseib Mbengue	289381	1601870
8	Malicounda Bambara	288154	1599884
9	Drilling/ health post of Malicounda Bambara	287228	1599518
10	Ngoukhoudj	289345	1599436

Specifically, it is a matter of comparing the measurements carried out in the rules of the art with the national regulations or even some good practices.
The atmospheric emission standards used in this study are listed in the following table.
It is noteworthy that the reference values used for the directives of standard NS 05-062 are those relating to a context of a non-degraded quality of air.

Table 33: Applicable Emissions Standards (cf. annex 05)

Pollutants	**Type of average**	**Maximal Limit Value**			
		WHO Directives	**NS 05-062 (Senegal)**	**US EPA (USA)**	**EU**
Sulphur dioxide (SO_2) (in µg/m^3)	Hourly	500 (10 mn) 350 (1 hour)	-	200	350
	Daily	20	125	-	125
	Annually	50	50	-	-
Nitrogen dioxide (NO_2) (in µg/m^3)	Hourly	200	200	190	200
	Annually	40	-	100	40

Pollutants	Type of average	Maximal Limit Value			
		WHO Directives	**NS 05-062 (Senegal)**	**US EPA (USA)**	**EU**
Hydrocarbons polycyclic aromatics (HAP) (mg/m^3)	Hourly	--	20	--	--
Ozone (O_3) (in µg/m^3)	Hourly 8 hours	- 100	- 120	- 150	-
Carbon monoxide (CO) (in µg/m^3)	hourly	30 000	-	-	-
	8 hours	10 000 30 000	26,19 ppm (30 mg/m^3) (24h)	40 000 (1h) 10 000 (8h)	10 000
Particles <10µm (PM_{10}) (in µg/m^3)	Daily	50	260	150	50
	Annually	20	80	-	20
Particles <2,5 µm ($PM_{2,5}$) (in µg/m^3)	Daily	25	WHO APPLIED NORMS	35	
	Annually	10		15	20
Plomb (Pb) (in µg/m3)	annually	500 ng/m^3	2	5 ng/m^3	500 ng/m^3

The choice of pollutants studied in this study is aligned with the national dynamics in terms of monitoring ambient air quality (DEEC, CGQA).

Therefore, Bio Tox proceeded to sample gaseous pollutants and PM2.5, PM10 dust particles in the selected source points. The acquisition of micro-meteorological data was also carried out at the various selected sampling points. The results of the sampling can be seen below.

- **Concentration of gaseous pollutants NO2 et SO2 on emission**

The results of these measurements for the gaseous pollutants' concentration are in the following table.

Table 34 : Concentration of gaseous pollutants NO2 and SO2 on emission at potential receptors

Date	Localization	NO_2 µg/m^3	SO_2 µg/m^3	Observation
05 to 09 September 2017	Keur Maissa Faye	38.24	88.07	- Less than 20% at the limit of NO_2 - Less than 70% at the limit of SO_2
	Solar power plant of Malicounda	42.79	78.62	- Less than 22% at the limit of NO_2 - Less than 63% at the limit of SO_2
	Darou Thioubène	41.34	68.64	-Less than 21% at the limit of NO_2 - Less than 55% at the limit of SO_2
	Keur Wally	46.34	64.24	- Less than 24% at the limit of NO_2 - Less than 55% at the limit of SO_2

Date	Localization	NO_2 µg/m³	SO_2 µg/m³	Observation
	Malicounda Ngueurigne	29.22	68.31	- Less than 15% at the limit of NO_2 - Less than 55% at the limit of SO_2
	Masseib Mbengue	43.38	105.74	- Less than 22% at the limit of NO_2 - Less than 85% at the limit of SO_2
	Ngoukhoudj	29.40	69.56	- Less than 15 % at the limit of NO_2 - Less than 56% at the limit of SO_2
	Malicounda Bambara	35.89	83.78	- Less than 18% at the limit of NO_2 - Less than 68% at the limit of SO_2
	Drilling/health post of Malicounda	10.86	71.49	- Less than 6% at the limit of NO_2 - Less than 58% at the limit of SO_2
	Electrical substation of Malicounda	47.37	72.9	- Less than 24% at the limit of NO_2 - Less than 59% at the limit of SO_2

Average concentrations in NO2 and SO2 from 05/09/2017 till 09/09/2017 in Malicounda before implementing the diesel power plant

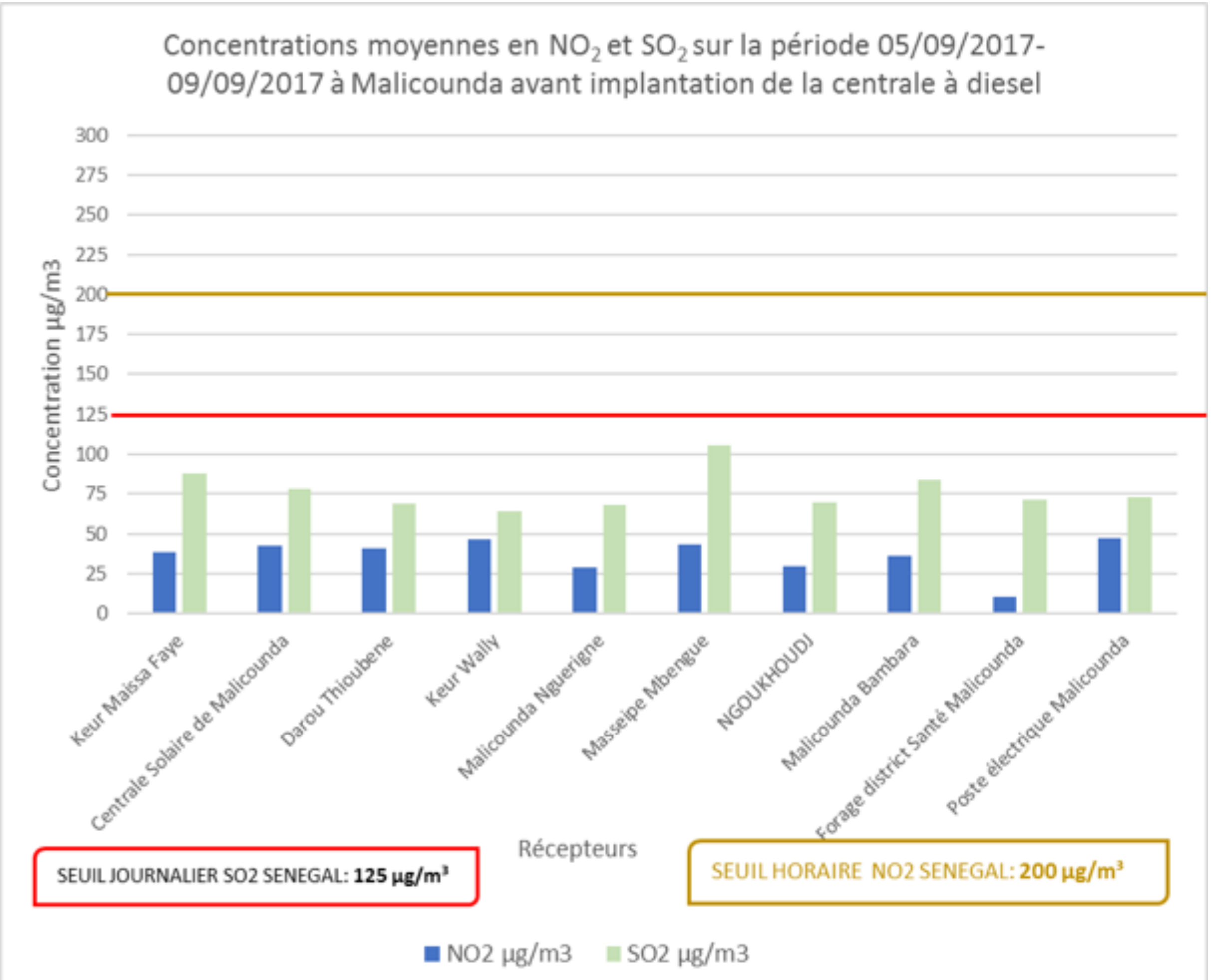


Figure 4: Average concentrations of SO2 and NO2 on potential receptors of the fuel oil power plant project in Malicounda

Legend: Senegal SO2 daily threshold: 125 µg/m3/ Receptors/ Senegal NO2 hourly threshold: 200 µg/m3

The average concentrations of gaseous pollutants NO2 and SO2 measured at the intake remained well below the standards in force in Senegal.

Nevertheless, it is important to report the effectiveness of micro-traffic on the Malicounda level for the populations' transportation and in relation to the various projects identified in said locality with NO2 emissions especially without having a negative impact on the quality air. Overall, the NO2 and SO2 concentrations at the measurement sites do not vary significantly from one receptor to the other. And the absence of a major source of air pollution in the area could largely explain these low concentrations compared to the standards in force. However, the SO2 levels are closer to the Senegalese limit (see table 19).

NO_2 concentrations of less than 25% are observed at the permissible limit, and SO_2 levels closer to the limit constitute less than 60%. The maximum recorded in the project area for SO_2 is at Keur Masseib Mbengue with 105.74 µg / m3.

Microclimatic conditions also contributed to lower pollution levels at the time of the measurements. In fact, the climate notably affects the dynamics of dispersion of particles in the atmosphere.

- **PM Concentrations in ambient air**

The following table provides information on the values recorded at the considered receptors

Table 35 : Particle Matter pollutants PM2,5 and PM10 emission concentrations and potential receptors

Date	Location	$PM_{2.5}$ µg/m^3	PM_{10} µg/m^3
05 till 09 September 2017	Keur Maissa Faye	10.2	16.34
	Solar Malicounda Power Plant	13.04	17.28
	Darou Thiou bène	13.63	22.28
	Keur Wally	10.852	20.67
	Malicounda Ngueurigne	11.556	23.04
	Keur Masseib Mbengue	10.118	26.45
	Ngoukhoudj	18.424	29.73
	Malicounda Bambara	10.6775	22.42
	Drilling/health post of Malicounda	12.758	30.1
	Electrical sub-station of Malicounda	16.645	25.32

Average concentration in fine particles PM2,5 from 05/09/2017 till 09/09/2017 in Malicounda before implementing the diesel station

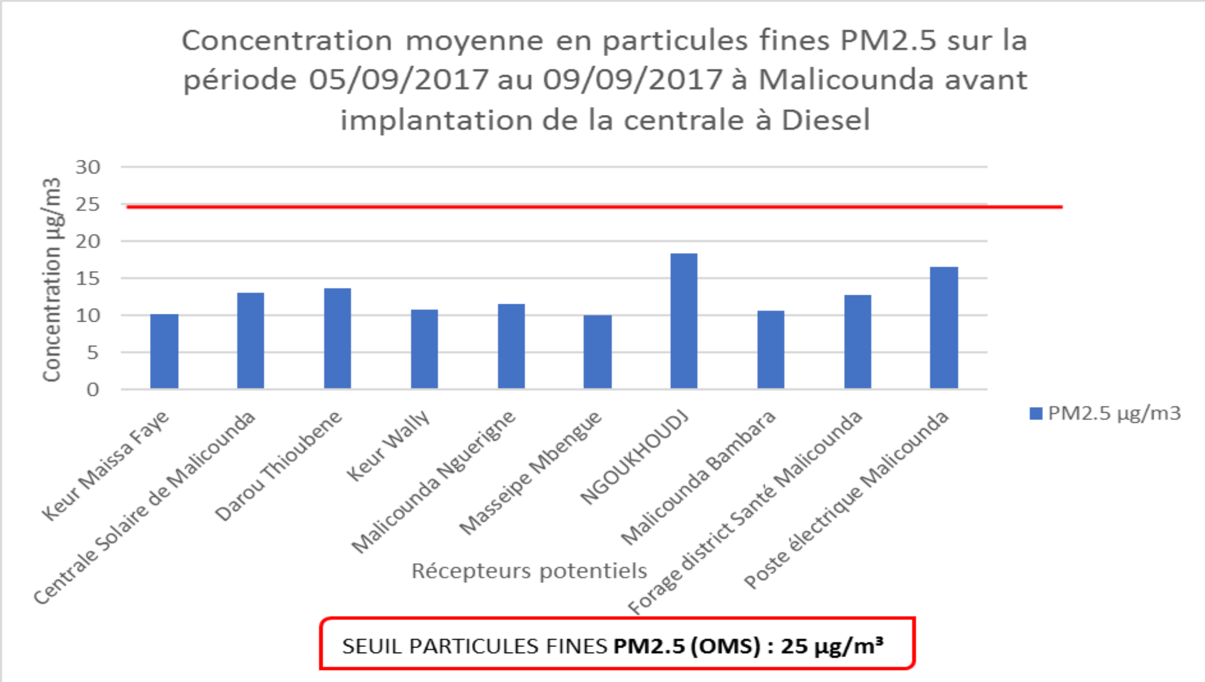


Figure 5: Particles PM2.5 emission concentration at potential receptors

Legend: Potential receptors/ PM2.5 (OMS) fine particles threshold: 25 µg/m3

Average concentrations of the gross fraction of fine particles in suspension PM10 from 05/09/2017 till 09/09/2017 before implementing the diesel station

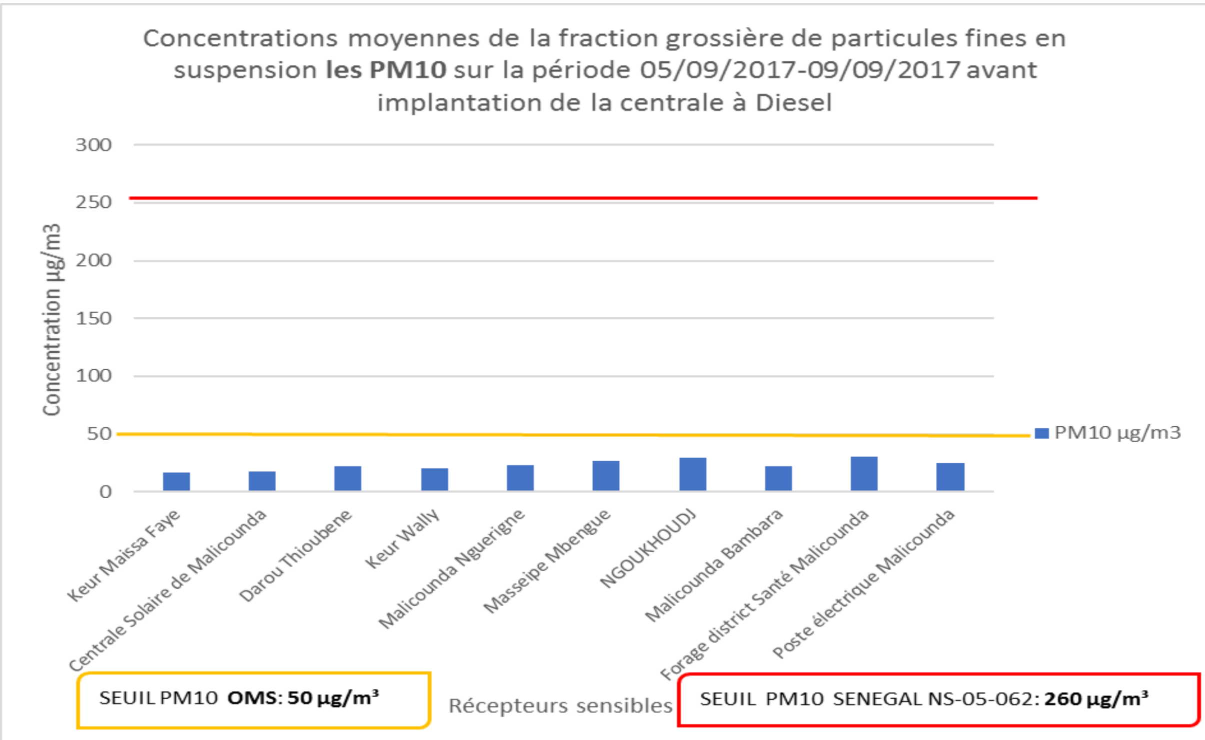


Figure 6: PM10 Particle emission concentration at potential receptors

Legend: PM10 threshold: 50 µg/m3/ NS-05-062 Senegal PM10 threshold: 260 µg/m3

The average daily concentrations of $PM_{2,5}$ and PM_{10} remained pretty lower than the standards in force. The absence of a major source of air pollution and the favorable climatic conditions greatly contributed to lowering the levels of PM in suspension in the project area. Thus, currently, the levels of PM_{10} and $PM_{2.5}$ suspended particles in the different localities do not vary from one site to another as illustrated in Figures 3 and 4. PM_{10} has also remained far below the standards of both the WHO and Senegal.

The highly noted use of biomass in households has not really deteriorated air quality in the area. Moreover, the fact that the measurements are taken during the wintertime (September) and that the high humidity at the time of the combined measurements, most often due to a certain hydrophilicity of the aerosols, can considerably lower their concentration in the atmosphere.

PM_{10} remain globally of natural origin (mineral erosion) and more or less of anthropogenic origin (wear of tires, road surface, brake linings). Their evolution in the atmosphere is very strongly linked to climatic conditions, especially wind and humidity which can favor either their mobilization or their sedimentation. This could largely explain the low levels of PM encountered in the area at the time of the measurements (September).

Regarding PM $_{2.5}$, they are mainly of anthropogenic origin (combustion waste, condensation and nucleation). The absence of a major source of air pollution in the project area explains to some extent the very low concentrations obtained during monitoring.

In summary, the campaign to measure atmospheric emissions at the various sites that could potentially be impacted by the future Malicounda thermal power plant, made it possible to assess the state of air quality.

The result is fairly good air quality with pollution levels well below national and international standards. The concentrations of gaseous pollutants NO_2, SO_2 and $PM_{2.5}$ and PM_{10} measured at the different sites have remained very low and do not vary much from one site to another. This statement comes to confirm the absence of any significant source of air pollution in Malicounda area.

There are, however, trends in SO2 closer to the Senegalese limit, probably due to the heavy use of solid fuels as an energy source in most households and traffic. The risk of pollution is very minor at the present time in Malicounda with weather conditions favorable to the leaching of aerosols into the atmosphere.

V.5.5.2. CLIMATE GENERAL CHARACTERISTICS

Located on the edge of the Senegalese coast, the Malicounda community, area containing the Power plant, is located in the North Sudanese coastal climatic domain. Located between isohyets 500 and 600 mm, the climate of the project area is characterized by a long dry season from November to May and a short rainy season from June to October. The area is marked by the influence of the Atlantic Ocean (maritime trade wind) and continental winds (continental trade wind or harmattan) during the dry season and by the climbs (monsoon) of the intertropical convergence zone during wintering.

The sea trade wind is a cool, humid wind from north to northwest. It blows from December to February and is unable to generate precipitation.
The continental or harmattan trade wind is a hot, dry wind, with an easterly dominant direction. It intervenes in the area during the period from March to June. It carries fine particles of sand and suspended dust and contains dry air with a high evaporation capacity.
The monsoon is the extension of the ocean trade winds of the southern hemisphere when it crosses the geographic equator. It comes from the Saint Helen high pressure. Its dominant direction is from the South to the West, observed during the rainy season. The advent of the monsoon marks the start of the rainy season at the commune level.

V.5.6.CLIMATIC PARAMETERS

To better understand the climatic behavior at the level of the project area, the following climatic parameters were studied: winds, insolation, temperatures, precipitation and relative humidity.

The analysis of these parameters were made from climatic data recorded at Mbour station, being the closest weather station to the site of the power plant. These different parameters are analyzed over a period of thirty (30) years, i.e. from 1987 to 2016.

V.5.6.1. WINDS

For the analysis of the variation of the wind direction, the monthly average in percentage of each direction of the eight (08) directions shown in Figure 2 is calculated.

V.5.6.1.1. Wind speed

Analysis of the anemometric data shows a uni-modal evolution of the monthly wind averages with a normal of 2.7 m / s. The maximum occurs in April (3.2 m / s). From June, the wind speed begins to decrease until October. The minimum occurred in September (2 m / s). Thus, the highest speeds are recorded during the dry season and the lowest during the rainy season.

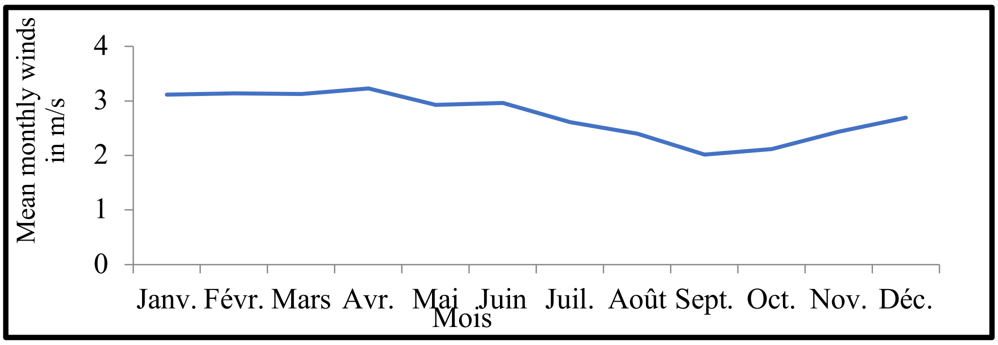


Figure 7 : Monthly average of the wind speed from 1987 to 2016 at the Mbour station
Source : ANACIM 2017
Legend: January/February/March/April/May/June/July/August/September/October/November/December/Months

V.5.6.1.2. Wind direction

Due to its position on the coast, Malicounda is swept by three (03) types of flow: the maritime trade wind, the continental trade wind and the monsoon. Analysis of the area's wind rose reveals two (02) distinct wind seasons:

- **from November to April**, north and north-easterly winds: the NE component dominates traffic with the highest frequencies in November (43%), February (63%), March (70%) and April (57%). The direction dominates the circulation in December (40%) and January (50%). These NNE direction winds are those of the Harmattan blowing in the area during this period. However, even if we note the dominance of the northeast and east winds, we have the presence of northerly winds. These winds occur from October to April with frequencies varying between 7 and 23%. The predominance of the continental trade wind is interrupted from time to time by the maritime trade wind, which generally intervenes in the area in December, January and February. This period corresponds to the non-rainy season in the project area.

The month of May, when the winds are oriented from north to west with the mostly west direction (50% of the frequencies), marks the transition from the non-rainy to the rainy season. The trade wind and the monsoon blow at the same time during this period.

- from **June to October**, westerly winds dominate with the highest frequencies in June (67%), July / August (50%), September (70%) and October (53%). These westerly winds are those of the monsoon, which are humid because of their long sea journey. This period coincides with the rainy season.

October is also a transitional month between the rainy and non-rainy seasons, generally dominated by westerly winds.

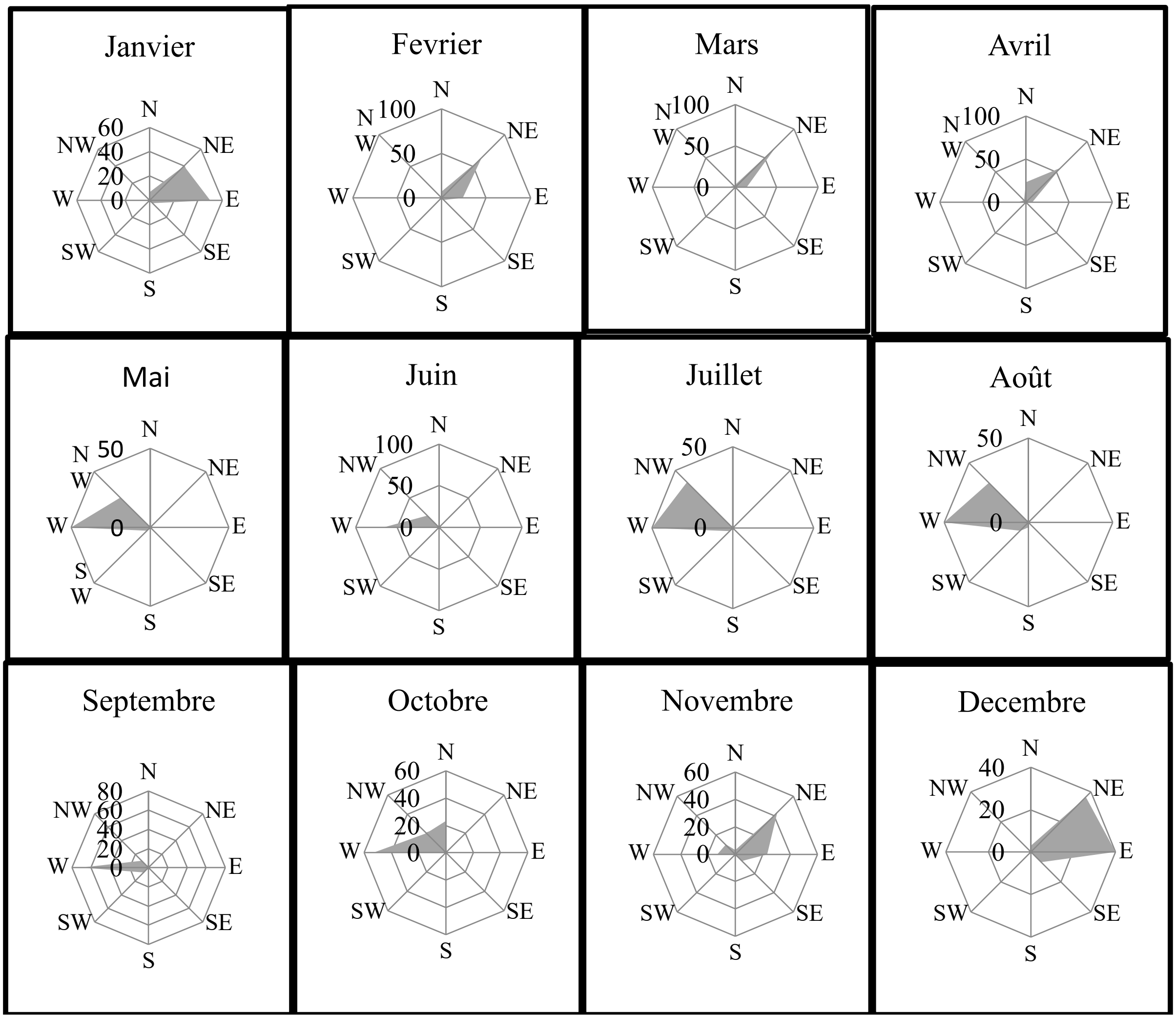


Figure 8 : Dominant wind directions at the Mbour station from 1987 to 2016
Source : ANACIM, 2017

V.5.6.2. INSOLATION

The evolution of the insolation shows a bimodal pace with two (02) maximum and two (02) minimum. The main maximum is in March (273 hours per month) and the secondary maximum in October (245 hours per month). The main minimum is recorded in September (213 hours) and the secondary minimum in February (229 hours). The norm is of 242 hours per month.

Thus, the highest sunshine values are recorded between March and June, a period coinciding with the dry season, characterized by less cloudy skies. From July, the values begin to decrease to reach the main minimum in September, in the middle of the rainy season. This period is marked by the presence of more cloud cover and relatively abundant precipitation, which reduces the intensity of the sun's rays.

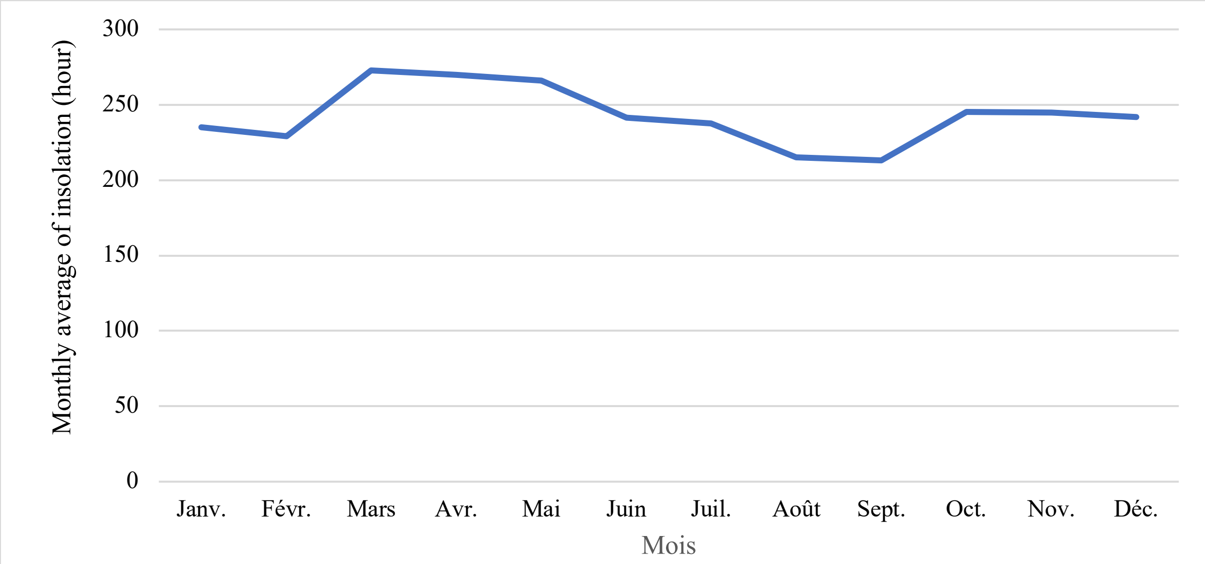


Figure 9 : Evolution of the insolation monthly average at the Mbour station from 1987 to 2016
Source : ANACIM, 2017
Legend: January/February/March/April/May/June/July/August/September/October/November/December/Months

V.5.6.3. Temperature

It is generally low in the project area due to the influence of the sea. The average annual temperature recorded at Mbour station is 27.3 °C. The average monthly temperature values range from 25 ° C (January) to 28.7 ° C (October).

The lowest temperatures are recorded between November and June during the dry season. During this period, the flows of hot and dry continental trade winds dominate the atmospheric circulation. However, they are influenced by the trade winds which tend to lower them, thus softening the climate, particularly between December and February. The period from July to October remains overall the hottest with an average exceeding 27.5 °C.

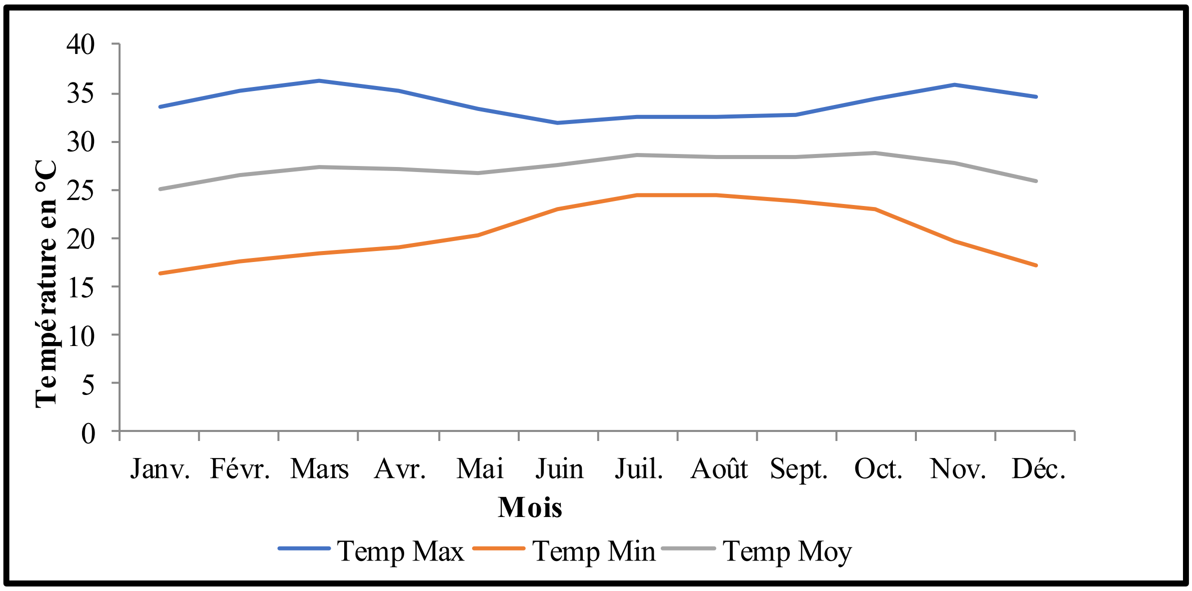


Figure 10 : Evolution of the monthly averages of temperature at the Mbour station from 1986 to 2017

Legend: temperature in °C/ January. February. March. April. May. June. July. August. September. October. November. December /months/ maximal temperature/ minimal temperature/ medium temperature

Source : ANACIM 2017

V.5.6.4. EVAPORATION

Average evaporation is 139.4 mm / month. The evolution of evaporation shows a uni-modal pace. The maximum is recorded in January (223.5 mm) and the minimum in September (59 mm).

Evaporation is the highest during the dry season from November to May. In fact, during this period, the area experienced the incursion of the hot and dry harmattan. This drought is accompanied by a rise in temperature which accentuates the importance of evaporation. On the other hand, during the rainy season, the cloud cover, the cloudiness, the amount of rain among others constitute factors reducing the evaporating power of the soil.

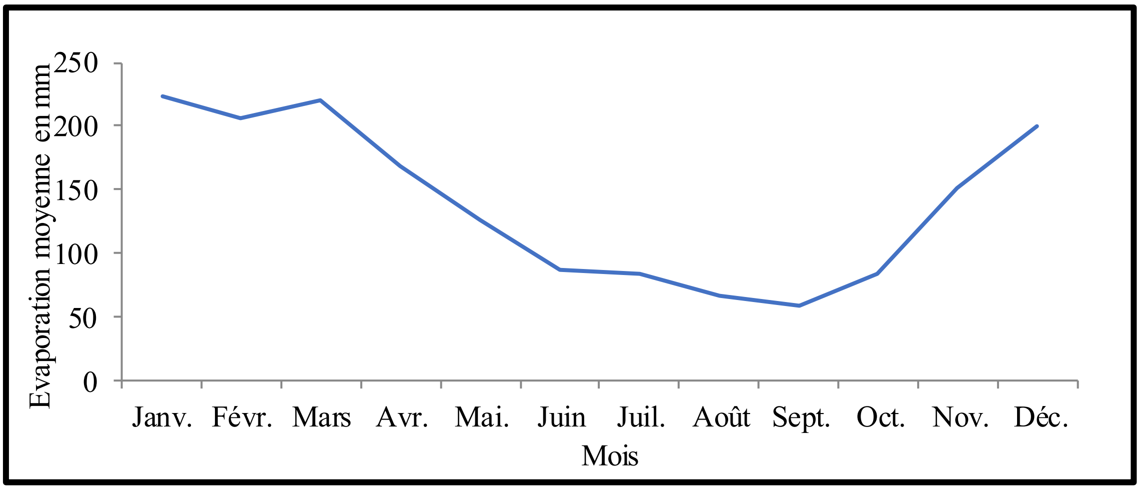


Figure 11 : Evolution of monthly evaporation averages

Source : ANACIM, 2017

Legend: average evaporation in mm/ January. February. March. April. May. June. July. August. September. October. November. December /months

V.5.6.5. RELATIVE HUMIDITY

Analysis of the curve of monthly averages of relative humidity shows a uni-modal evolution. The maximum is recorded in September with 84.4% and the minimum in January with 49.8%. The most important values are recorded during the rainy season between June and October. This is due to the presence of the monsoon which is characterized by high humidity in addition to the drop in temperatures and the low wind speeds which also influence the increase in humidity.

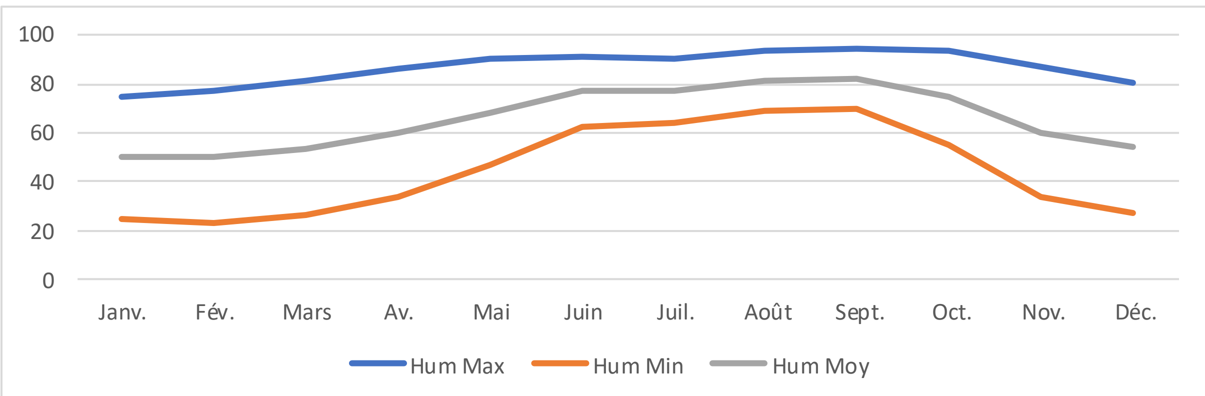


Figure 12 : Evolution of the monthly averages of humidity at the Mbour station
Source : ANACIM, 2017
Legend: January. February. March. April. May. June. July. August. September. October. November. December /maximal humidity/ minimal humidity/medium humidity

V.5.6.6. RAINFALL

The Malicounda power plant site is located in the coastal North Sudanian climatic range, between the 500 and 600 mm isohyets. Rainfall is marked by an inter-monthly and inter-annual variability.

V.5.6.6.1. Monthly Variances

The rainy season lasts 4 to 5 months in the area and settles in late June / early August to withdraw starting the month of October. The annual rainfall rate is 610.7 mm.

Most of the seasonal accumulation is recorded between July and September. The maximum is recorded in August, which remains the rainiest month with 253.8 mm.

Apart from winter precipitation, rain occurs out of season also called rains “Heug". They are associated with polar air invasions. These rains are generally light or even insignificant.

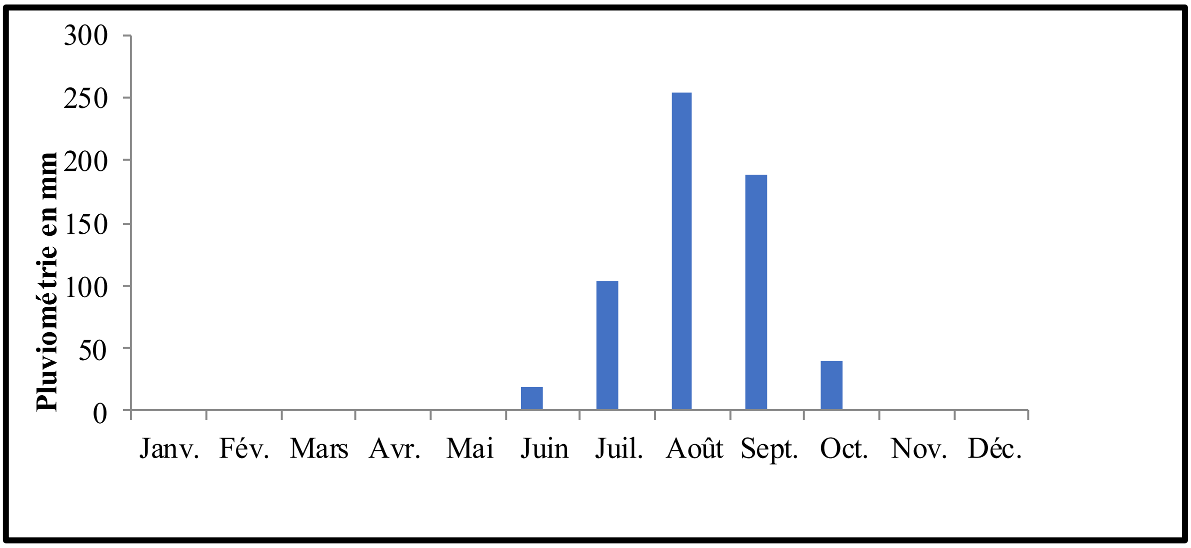


Figure 13 : Evolution of the monthly rainfall averages at the Mbour station
Source : ANACIM, 2017
Legend: pluviometry in mm/ January. February. March. April. May. June. July. August. September. October. November. December

V.5.6.6.2. Inter-annual Variances

The figure below shows the evolution of the inter-annual rainfall at the Mbour station. Rainfall is irregular from year to year. The average annual rainfall is 566.3 mm. The minimum was observed in 2002 with an annual rainfall rate of 311.5 mm. Among the years 1987 to 2016, 2015 was the wettest year with an annual rainfall rate of 952.9 mm.

Rainfall is the main factor in flooding. This is a parameter to be taken into account by the promoter in its storm water management program at the site.

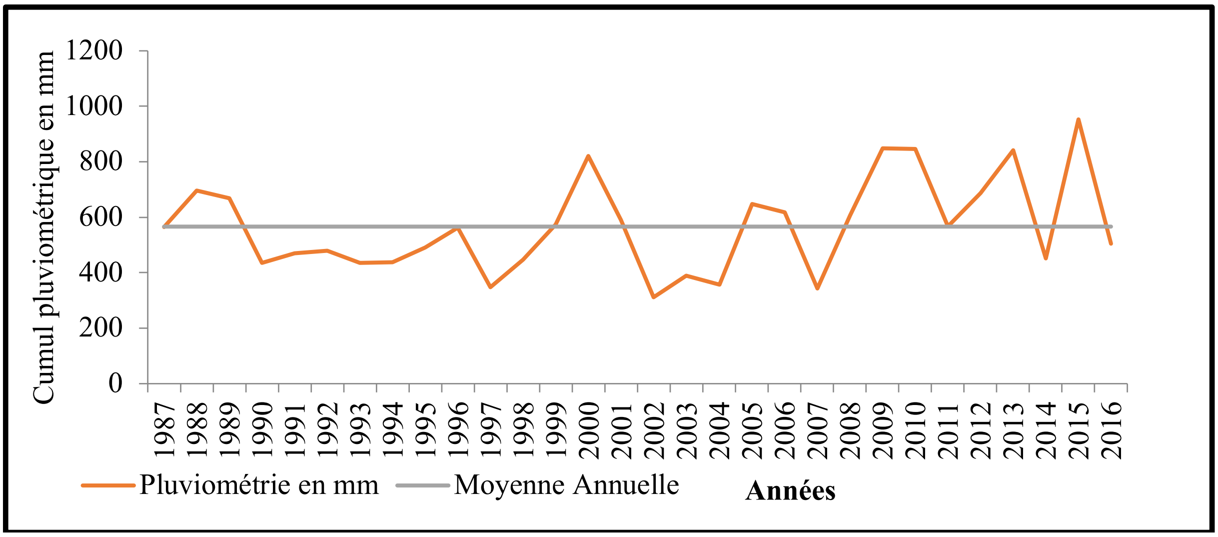


Figure 14 : Evolution of the annual rainfall averages at the Mbour station

Source : ANACIM, 2017

Legend: cumulative pluviometry in mm/ pluviometry in mm/ annual average/ years

V.5.7. STUDY OF THE INITIAL SOUND ENVIRONMENT

The purpose of this study is to characterize the initial noise level as part of the environmental and social impact study of the 120 MW power plant to be installed in Malicounda near the SENELEC high-voltage substation. The measurements were made with reference to the HSE directive of the World Bank and to the so-called "expertise" method of standard NF S 31-010 and ISO standard 1996-1 (2003). This initial characterization is required for a better evaluation of the impacts of the project on its host environment.

V.5.7.1. METHODOLOGY AND USED EQUIPMENT

Day and night measurements were carried out on the site in the initial state from June 22 to 25, 2018. During the day, the integration sound level meter was used for readings carried out in the various areas frequented by operators on a duration of 15 hours (from 7 a.m. to 10 p.m.) for each measurement while in the night period, over a duration of 09 hours (from 10 p.m. to 7 a.m.). It is assumed that the operators are subjected over a given period to the average of the noise level recorded in the area of the measurement.

The integrating sound level meter used, type PCE-322A, is a noise measuring device in the following noise measuring ranges: 30 - 130 dB. It is mounted on a tripod to ensure its stability at approximately 1m to 1.50m from the ground. Three (03) measurement points were listed in total for this campaign. They were taken near the study area and the dwellings closest to the site.

V.5.7.2. MEASUREMENT AREAS

Only one (01) single measurement point among the three (03), **P1,** is concerned with the site of the power plant. The other two (02) points, **P2** and **P3**, are located respectively in Malicounda Wolof, near the road and in Malicounda Bambara, near schools and residential areas. The following map illustrates the positions of the different measurement points.

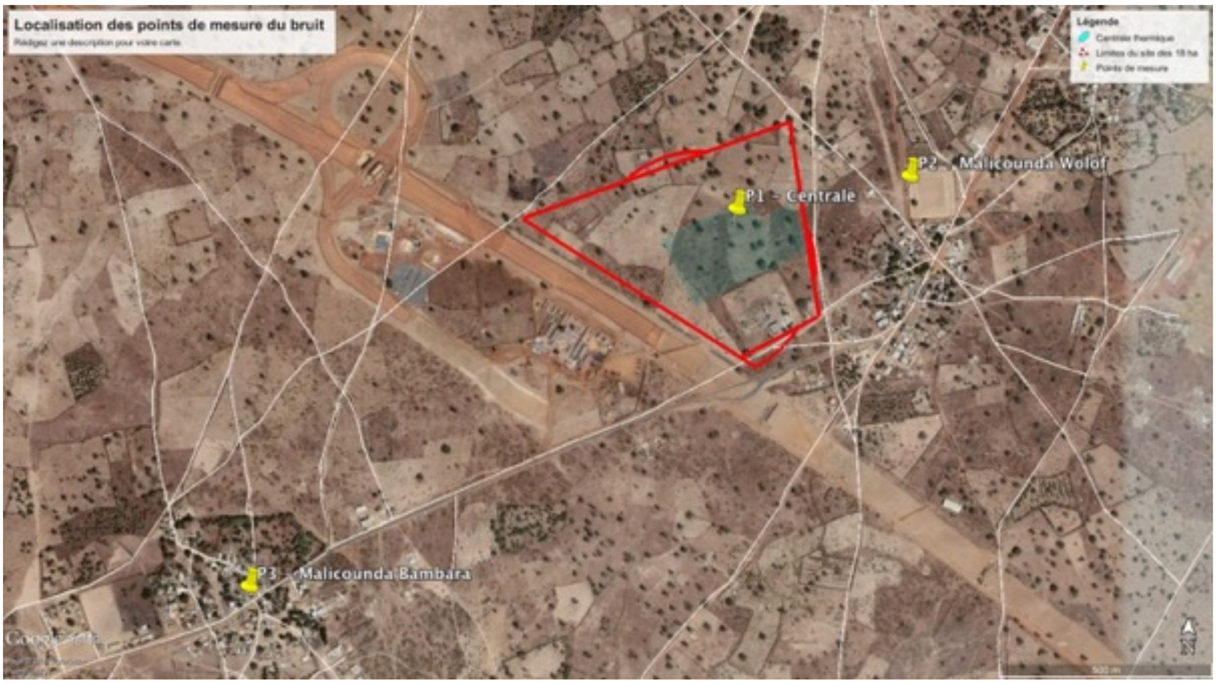


Image Google Earth 2 : Noise measurement points

V.5.7.3. Table of results

The following table summarizes the results:

Table 36 : Results of the interpreted measurements

	Points of measurements	Coordinates		Average value in dB (A) – Daytime	Average value in dB (A) – Nighttime	Conclusion
		X	Y			
1	P1	289782	1600826	45.35	44.60	Calm
2	P2	290138	1600881	39.59	39.30	Calm
3	P3	288649	1599906	43.22	40.81	Calm

This report examined in these three (03) points, the noise level at the property boundary and compared it to ISO 1996-1 (2003) limit values. The points to consider are points P2 and P3.

The average value of each point must be less than or equal to 55 dB (A) between 7 a.m. and 10 p.m. (daytime period) and less than 45 dB (A) between 10 p.m. and 7 a.m. (night period) as required by the World Bank.

Figure 15 : Sound measuring procedure

Legend: noise source/measuring point

V.5.7.4. Conclusion of the study on the initial sound environment

After a study of the grounds, we noted a relatively calm environment with a level of residual noise respecting the recommendations of the World Bank, day and night. The environment in the initial state is therefore of the unpolluted type from a sound point of view.

V.6. Description of the biological environment

The study on the biological environment concerns the description of the initial state of the flora and fauna but also endeavors to analyze the possible impacts of the installation of the thermal power plant on the natural environment.

V.6.1. Flora

The area to house the Malicounda power plant is located in the Sudanian domain which is that of the savannah under different physiognomies. Indeed, the vegetation of the project area is of the savannah type with trees and shrubs with an herbaceous carpet which generally dries up from November.

This tree and shrub savannah consists mainly of Faidherbia albida (Kaad) Balanites aegyptiaca (Soump), Adonsonia digitata (gouy), Acacia seyal (Sourour), Ficus gnaphalocarpa (Gang), Prosopis juliflora, Prosopis africana (iir), Eucalyisus camald Khotou boutèle), Azadirachta indica (Niime), Ziziphus mauritiana (Sideem), Acacia nilotica (red gum), Acacia tortilis (Seing), Acacia senegal (Verek) Guiera senegalensis (Nger), Euphorbia balsamifera (Salane), Combretum glutinosum (Ratt).

The herbaceous layer is composed of annual grasses dominated by Cenchrus biflorus (cram-cram),

Calotropis procera (Paftann).

It is noteworthy that the methods of land use and the farming methods practiced in the area leave little room for native flora.

In the site hosting the project, the present plant species are dominated by Guiera senegalensis, Ziziphus mauritiana, Faiderbia albida, Acacia seyal, Prosopis juliflora, Calotropis procera, Combretum glutinosum and to a lesser extent Leptadania hastata (Thiakhat).

Also, on the site, the presence of Adansonia digitata (1) and Faidherbia albida (Kaad) was also identified. The latter are species partially protected by the Forest Code in force in Senegal. Thus, they cannot be cut down, limbed or torn off without prior authorization from the Water and Forest Service.

The scanty and undiversified vegetation in and near the site to house the power plant is due to the degradation of the environment strongly influenced by the strong pressure exerted by humans (agricultural activities, habitats, transport infrastructure, etc.).

V.6.2. FAUNA ET AVIFAUNA

The vegetation of the site is strongly marked by human activities, more particularly agriculture, which thus modifies the habitat of the fauna.

In fact, the site to house the thermal power plant is agricultural land mainly dedicated to rain-fed crops, notably peanuts, millet, cowpeas and corn (by degree of importance).

Rodents thrive in this environment, and they mainly consist of cultivable land where they dig their burrows.

The fauna species present are limited to a few rare reptilian species (lizards, snakes, salamander, etc.), Xerus erythropus (palm rat), Xérus inauris (burrowing squirrel) and avian fauna often passing through the area.

There is little wildlife potential in the project area, mainly due to human pressure on wildlife habitats. Most of the species in the area are concentrated in the Bandia reserve located about 9 km from the power plant and in the classified forests of the area.

V.6.3. HABITATS

A habitat, as defined by the Merriam Webster online dictionary is the place or environment where a plant or animal naturally or normally lives and grows. It therefore brings together the physical and biological conditions necessary for the existence of an animal or plant species and can constitute a homogeneous space relating to its ecological conditions and its vegetation (herbaceous, shrubby and tree-like) which can host species carrying out all or part of their life cycle in this space.

Natural habitats generally constitute true refuges of biodiversity. However, these natural habitats are very rare in the project area due to the strong human presence, which shifted from a savannah-tree to shrub environment into an open system of crops that has considerably reduced natural areas.

Similar to the project area, the habitats on the site to host the thermal power plant are essentially rain-fed croplands dotted with a few woody species and hedgerows bordering the crop plots that constitute refuges for wildlife.

The hedges and plots of crops are home to a highly undiversified entomofauna (crop pests and auxiliaries) and a mammal made up of small rodents. As for the isolated trees, they mainly serve as habitats for certain birds.

In addition, the station site is very poor in natural habitats. The loss or deterioration of habitats on the station site is mainly due to agricultural practices (use of fertilizer, weeding, tillage, etc.). However, no particularly sensitive wildlife habitat was observed inside the site to host the project: Ecosystem services.

The ecosystem in the project area is a humanized and cultivated ecosystem. It is the result of human manipulation of the natural ecosystem. In fact, local populations depend on the exploitation of organic products to meet their food, medicinal and service needs. In addition, they relate to the benefits that people derive from ecosystems. Ecosystem services on the site to host the power plant include:

- sampling services (food, firewood, service wood, pharmacopoeia);
- regulatory services (water, air, soil, climate);
- cultural services (spiritual, recreational, aesthetic).

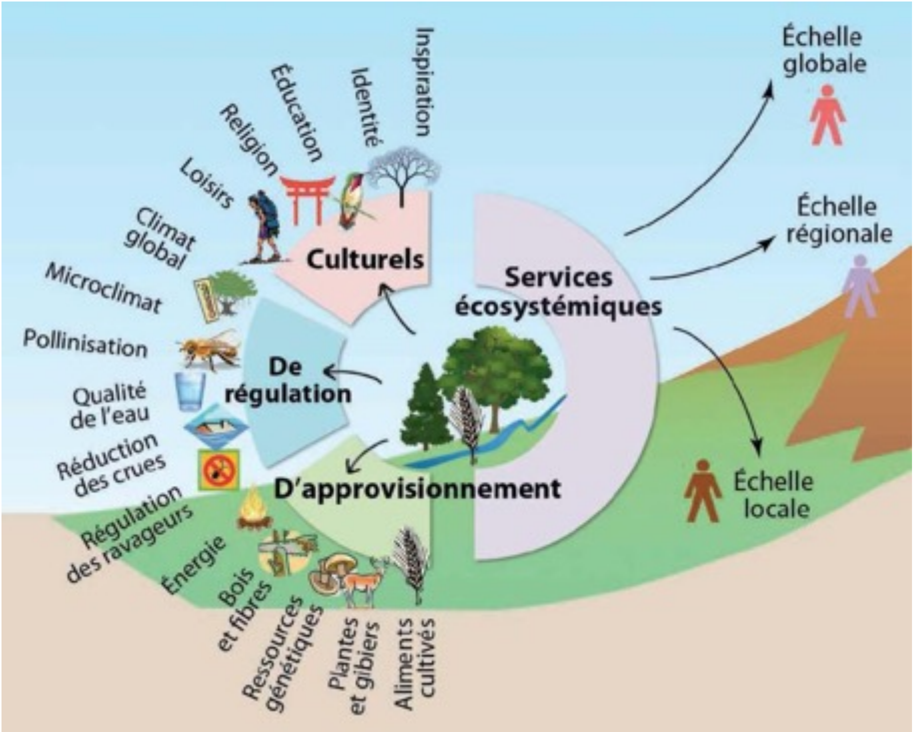


Figure 16 : Example of an agricultural ecosystem (Source : L'écosystème agricole, PatrickHautefeuille, Octobre 2017)

Legend: inhalation- identity- education- religion- activities /cultural/ global climate- microclimate- pollination- quality of water-reduction of floods- pest regulation/for regulation/ energy- wood and fiber- genetic resources- plants and animals- grown food/ for supply/ global scale- regional scale- local scale/ Eco-systematic services.

The primary ecological functions of the project area have been greatly modified by the agricultural activities carried out on the environment. Indeed, the site of the power plant shelters some forest plant species which were established by the farmers.

However, the project site does not represent a particular ecosystem because on a radius of 500 m on either side of the boundary of the station site, the plant cover is identical to that of the site. However, the establishment of the power plant will result in a loss of these services, which will have negative impacts on the affected communities.

V.6.4. Protected areas

The village of Malicounda has two (02) Classified Forests (CF) located south of the power plant. However, it is noteworthy that the Bandia reserve is 9 km north of the power plant.

Table 37: List of the classified forests in the village of Malicounda

Protected area	Land area	Distance to the station	Location according to the station
CF of Balabougou	222 ha	15 km	South
CF of Nianning	3,1 ha	16 km	South

Finally, the available potential is the subject of various uses by populations, notably human food, cattle feed, organic fertilizer, fuel wood, service wood and the pharmacopoeia. Forest fruit trees can be sources of income for people. This strong pressure exerted on plant resources in addition to drought are the main causes of regression of vegetation inducing a disappearance or migration of fauna and avifauna towards other milder horizons.

V.7. Description of the human environment

V.7.1. Demographic situation

The area of Malicounda expands on 124 km2 for an estimated population of 69,932 inhabitants including 35,877 men and 34,056 women in 2018.

The following figure shows the evolution of the population of Malicounda.

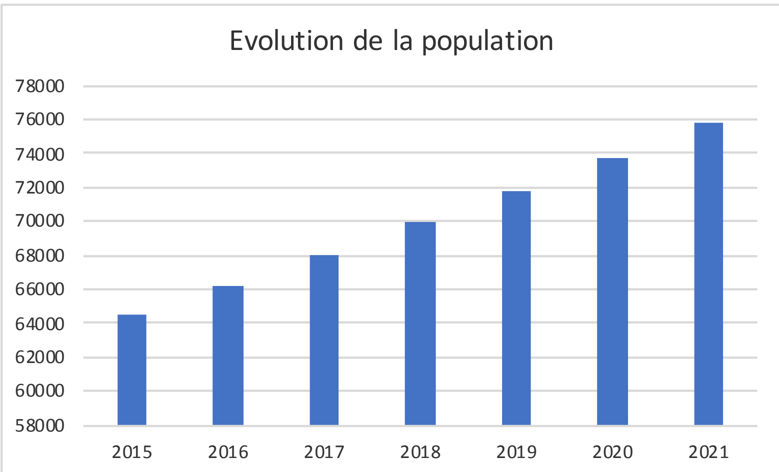


Figure 17 : evolution of the population in Malicounda from 2015 to 2021
Source : ANSD

The ANSD forecasts describe a population increase over the next four (04) years with an average annual growth rate of 2.6%. It is noteworthy that the population of Malicounda is mainly made up of young people. In other words, more than half of the inhabitants are under 25 years of age.

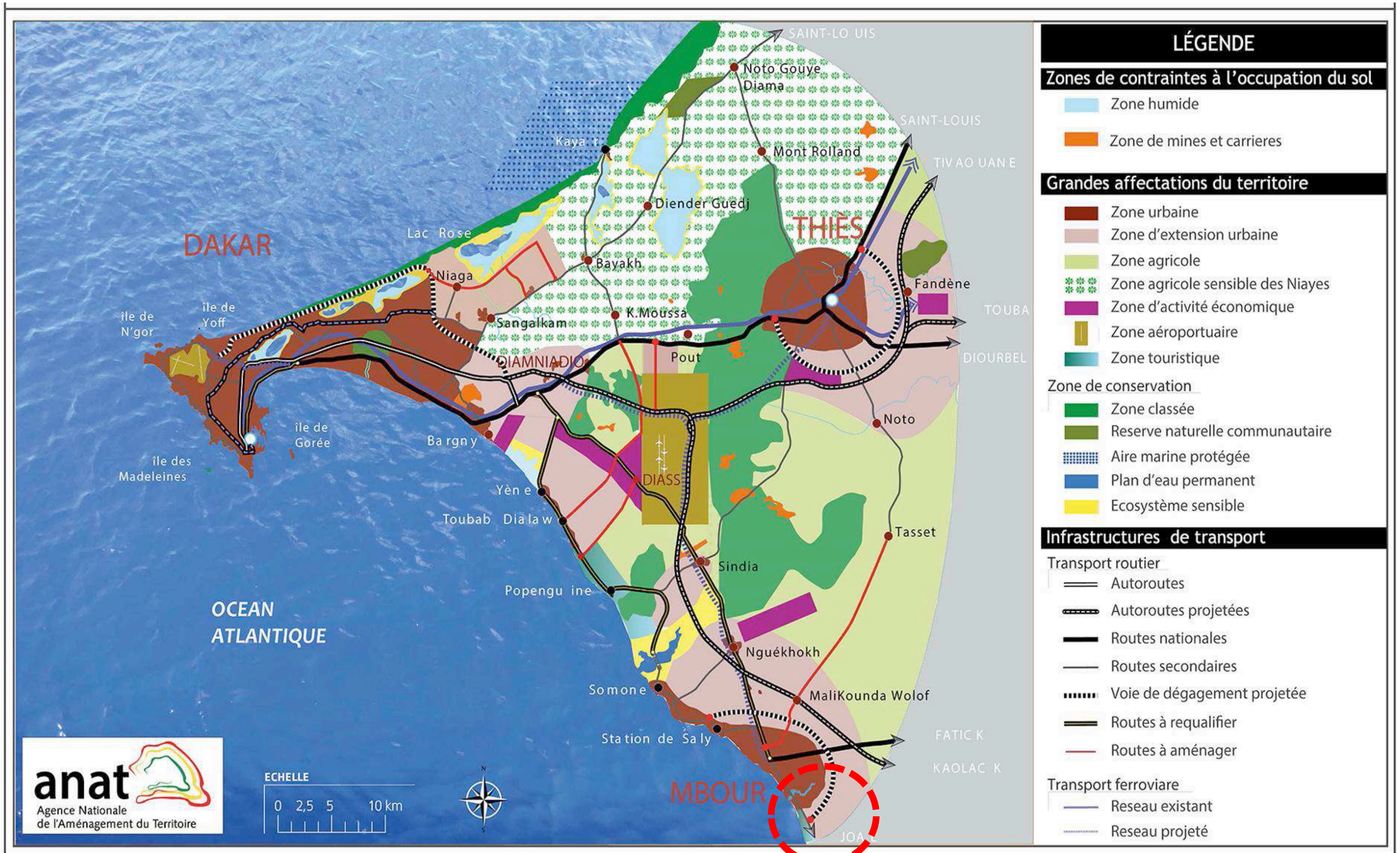
In Malicounda, cultural diversity is favored by the presence of different ethnic communities composed mainly of Wolofs, Sérères and Bambaras. Moreover, these largely Muslim ethnic groups are concentrated by sector in their respective villages bearing the name of the dominant community (Malicounda Wolof, Malicounda Sérère and Malicounda Bambara).

This cohabitation is highly appreciated by the populations and in 2015 favored the organization of the Festival of the Town of Malicounda, which advocates the promotion of local culture.

The project implementation site is surrounded by the villages of Malicounda Wolof, Malicounda Serere and Malicounda Bambara.

V.7.2. SPATIAL PLANNING-LAND OCCUPATION-LAND PROBLEMATIC

The land policy of the Town of Malicounda is called upon to adapt to the new allocation of land described by the main plan for spatial planning and development of the Dakar-Thiès-Mbour area. This scheme allocates land to Malicounda for an urban extension area.



Map 8 : Major assignments of the "zoom on Malicounda"

Source : ANAT- schéma directeur d'aménagement et de développement Territorial de la zone Dakar-Thiès-Mbour

<u>Legend</u>: Constraint areas for the use of land/humid zone/mines and quarries zone/major uses of the territories/ urban zone/urban expansion zone/agricultural zone/sensitive agricultural zone of Niayes/ economic activities zone/airport zone/ touristic zone/conservation zone/ classified zone/Nature reserve of the commune/protected marine area/permanent water plan/sensible ecosystem/ transportation infrastructure/ road transportation/ highways/ planned highways/national roads/secondary roads/planned alternative roads/roads to requalify/roads to develop/railroad transportation/ existing network/ planned network

This land allocation could be justified by the new vocation of the Department of Mbour to be a metropolis. However, due to its growing demography, Mbour has practically no more habitable land. The extension of the chief town of the department can only be done from the Town of Malicounda.

In order to limit land disputes, the local authorities of Malicounda must systematically refer to the land use plan.

V.7.3. DRINKING WATER SUPPLY

The supply of drinking water to the project area is average due to the disparity of borehole coverage by village. In fact, the surrounding villages of the project site are supplied with drinking water by boreholes managed by ASUFOR.

Currently, the town has four (04) boreholes of which one (01) is under construction and two (02) are identified around the project site, in the villages of Malicounda Wolof and Malicounda Bambara.

Drilling in the village of Malicounda Wolof is facing a drop in pumping rate. Thus, it struggles to supply its very wide coverage area. In the initial state (1999-2000), the expected pumping rate was 23.5 m3 / h and it has increased to 15m3 / h today. These factors mean that in Malicounda Wolof, the rate of access to water is considered to be low, which favors the consumption of well water by the population.

On the other hand, in Malicounda Bambara, drilling covers more than 90% of the village's drinking water needs. It intends to cover the extension areas of the town over the years.

V.7.4. SANITATION AND WASTE MANAGEMENT

The region of Malicounda has no sanitation network. For the management of their wastewater, households have set up individual septic tanks. Depending on the filling of the latter, they call on providers for their emptying.

Photo 12 : Wastewater management- septic tank of ASUFOR of Malicounda Wolof

Source : EES, site visit of 27/07/2107)

Regarding waste, self-management is the most adopted method by households. This promotes the proliferation of anarchic garbage dumps.

At the level of the village of Malicounda Bambara, the population makes monthly contributions in order to pay for the services of a carter who collects household waste every two days. This waste is thus tansported to a wild landfill.

V.7.5. EDUCATION

The town has thirty-eight (38) elementary schools, five (05) middle schools and three (03) high schools. In the project implementation area, there are nine (09) elementary schools, three colleges including one (01) private. The nearest high school to the project location is located at Saly aerodrome (town of Saly).

Table 38 : Educational infrastructures identified in the power plant implementation area

Village	Elementary Schools	Colleges
Malicounda Wolof	03	-
Malicounda Sérère	03	-
Malicounda Bambara	01	02 (01of which is private)
Takhoum	02	01

Source : EES-field survey

In addition to conventional education, Koranic education is very developed in the commune. Almost all of the children attended Koranic school before they entered French school. However, the model so far remains very informal.

V.7.6. HEALTH

Malicounda has seven (07) health posts which are polarized by the district of Mbour. However, for very urgent cases, the Mbour Hospital is the very first option.

It is noteworthy that the Department of Mbour and the Region of Thiès are generally in clear progress in terms of health coverage. This is justified by the fact that after Dakar, Thiès is the first region where the mortality rate of 6.2% is the lowest compared to the national average which is 7.7%[8].These results are obtained on the one hand thanks to the high standard of living of the population carried by fishing, market gardening, mining and tourism activities and on the other hand by the strengthening of the health system of the region. This is mainly done through the strong presence of private health structures, especially clinics.

V.7.7. ELECTRICITY

The electrification of Malicounda is managed by the Senegalese Rural Electrification Agency (ASER) through the Tunisian company. According to the populations, the rate of electrification of the commune is increasing with the installation of the solar power plant of 22MW.However, the Municipal Development Plan (2016) emphasizes that certain localities do not yet have access to electrical energy such as Sinthiou Mbadane Sérère and Peulh, Soussane Sarène, Takhoum Wolof, Roff, Fandane and Sidibougou. Other villages such as Nianing, Falokh, Mboulème, Soussane Bambara are not yet fully covered and need a densification program. In 2018, only one village, not yet electrified, was identified in Malicounda.

V.7.8. ECONOMIC ACTIVITIES

[8] ANSD: general census of population and housing, agriculture and livestock, final report, region of Thies, April 2017

Due to its geographical position, Malicounda benefits from many natural advantages allowing it to practice various economic activities such as agriculture, fishing and animal husbandry. In the commune, other sectors of economic activity are developed, namely industry and energy.

V.7.8.1. AGRICULTURE

Agriculture is the main economic activity of the town. Millet, peanuts, cowpeas and corn are the main crops in the area. Besides, these cultures are still practiced on the project site.

Photo 13 et 14 : Farming practice in the project area

Source : EES, site visit of 27/07/2017

Apart from these seasonal crops mainly developed in the rainy season, market gardening is also practiced by women. Support for this practice prompted Malicounda solar power plant to install a borehole for them as part of its CSR program.

V.7.8.2. FISHING

Fishing is also a flagship sector in Malicounda. It is highly developed in the southern part of the town, especially in the villages of Mballing, Warang, Nianing and Pointe Sarène.According to the Town's Development Plan, Malicounda has a port in these fishing villages with an estimated fleet of more than 700 canoes. The 2015 catches are estimated at 1800 tons, equivalent to 1.7 billion CFA francs.

V.7.8.3. TRANSPORT

The AIDB-Mbour toll motorway will cross the Town of Malicounda. Moreover, an exit is planned very close to the project site, which will contribute to better access to the city and to the economic development of the town.

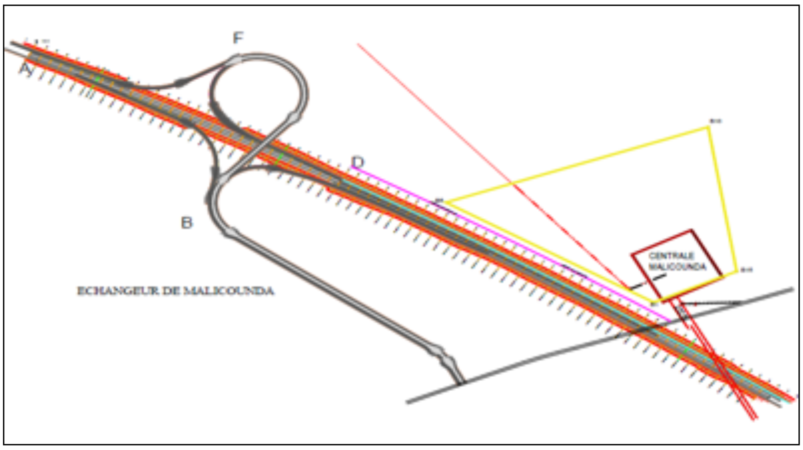


Figure 18: Layout of the AIDB-Mbour toll highway at Malicounda
Source : Ageroute (coordonnées) et EES (traitement de données)

V.7.8.4. Breeding and aviculture

Breeding is done informally in the town. Extensive breeding is not very developed due to the infrastructure deficit.

However, for savings needs or out of simple passion, households raise a few heads of cattle in their homes.

Around the project site, poultry farming is very developed with three (03) identified farms including one (01) in construction.

V.7.8.5. Commerce

Housing is developing, hence the establishment of hardware stores, restaurants, grocery stores, etc. for the needs of consumption It is noteworthy that the town does not organize a weekly market.

V.7.8.6. Energy industry

Malicounda tends to define itself as an energy hub. Indeed, the High Voltage (HV) substation, with the 22 MW solar power plant inaugurated in 2016 and the 120 MW thermal power plant to be built, the subject of this study, will make the town an essential platform in terms of energy production in Senegal.

V.7.8.7. Historical and cultural site

On the right-of-way of the site planned for the construction of the power plant, no presence of archaeological site, historic monuments, places of worship likely to be affected or threatened with disappearance due to the works, is noted. However, a cemetery exists approximately 100 m from the northern boundary of the site and will require special attention.

V.8. Environmental sensitivity of the surrounding

The table below presents some environmental components and their sensitivity to the project.

Table 39 : Environmental sensitivities

Area	Component	Characteristics (Description summary)	Sensibility towards the project
Physical	Air	Results of the emissions measurement campaign atmospheric conditions at the various sites that could potentially be impacted by the future Malicounda thermal power plant show that the air quality is relatively good with pollution levels well below national and international standards.	The construction and operation of the Malicounda thermal power plant will generate air pollutants and greenhouse gases tight. These emissions are likely to affect the air quality and climate.
	Climate	Winds are relatively frequent with higher speeds during the non-rainy season and the weakest, in the rainy season. Average temperatures are slightly higher during the rainy season while lower temperatures are recorded during the dry season. Relative humidity is high between May to October and low from November to April.	
	Topography	The plant site is located in an area where the land is relatively flat and monotonous with altitudes varying between 10 and 15 m.	The site does not require very large civil works.
	Underground waters	Two aquifers are exploited by the boreholes in service in the project area: x the water table with a depth varying between 10 and 30 m; x the Paleocene aquifer with a depth varying from 60 to 80 m; x the Maastrichtian aquifer which is a captive aquifer that is captured by boreholes with a depth that varies from 200 to 250 m.	The project involves the installation of one (01) borehole. An overexploitation of this groundwater can lead to competition with the needs in population water. The hazardous waste generated by the activities of the plant could be a source of pollution of the aquifer.
Biological	Flora, fauna and avifauna	The project site is a place of rain-fed crops (cowpea peanut, millet and bissap). It is dotted with fruit trees and therapeutic species. Two (02) partially protected plant species Andansonia digitata (Baobab) and Faidherbia albida (Kaad) have been identified.	To carry out the project, the site preparation and development work will lead to deforestation of the plant species present.

Area	Component	Characteristics (Description summary)	Sensibility towards the project
			These deforestation activities will have an impact on the wildlife habitats in the area.
Humans	Infrastructures	The project area is not very rich in wildlife species. We found rodents and certain reptilian species. Avian fauna is often in the area.	During this phase, several types of waste will be generated, which will impact on fauna and micro fauna. Finally, night work will affect certain wildlife species which are more active in this area.
	Socio-economic activities	In the project area are present: - the infrastructures that will coexist with the power plant are residential buildings under construction (82m north of the site and 241m from the power plant) and another construction which crosses the northern limit of the site; - the Ageroute base station, which is 124 m west of the site and the toll motorway site 40 m west of the site and 118 m from the power plant; - the houses of Keur Maissa Faye which are 39 m south of the site and 164 m from the power plant on the south side; - the tarmac road 55 m south of the site and 233 m from the power plant.	The construction work will be a source of discomfort for the activities carried out there and for the houses located near the power plant.
	Life context and sound environment	The main socio-economic activity that takes place within the project site is rain-fed agriculture.	The completion of the project will result in the cessation of agricultural activities that were carried out on the site.

VI. ANALYSIS OF ALTERNATIVES

VI.1. METHODOLOGY

Variant analysis is a chapter of the ESIA that allows you to make comparisons between different options for carrying out the project in order to offer the best possible. It is also about the "no project" option, which provides the justification for the project's “raison d'être” or the reason behind its creation in the first place. This analysis is based on the advantages and disadvantages of each option under study in order to optimize the promoter's choices in terms of security, economic, social and environmental. Within the framework of this study, the analysis of the variants was carried out for the following headings:

- the "without project" option;
- the location of the plant and the layout options;
- electric power generation technology;
- the technological process (simple cycle/combined cycle);
- water supply.

VI.2. “NO PROJECT” OPTION

One of the first alternatives studied is the "no project" option. This option would not contribute to the achievement of the objectives of SENELEC's new 2016-2020 Strategic Plan, which consists in obtaining a total production of 3527.6 GWh by 2020. It would also disagree with the energy policy of the country, namely ensuring the country's energy supply in sufficient quantity and widening people's access to modern energy services. From a socio-economic point of view, not carrying out such a project would therefore mean compromising economic, health and social development, which is currently marked by a low rate of energy supply to households, the tertiary and industrial sectors of country as well as a very high tariff. In addition, the failure to complete this project is a loss of opportunity for improving the quality of service. This option is a brake on the desire to fill the structural deficit recorded in recent years in the electricity sector. The cost per kWh will remain relatively high and the employment opportunities as well as the business opportunities for SMEs and SMIs linked to the construction and operation of the plant cannot be seized by the populations, especially the local ones.

From an environmental point of view, not carrying out the project would avoid potential negative impacts related to its construction and operation. Indeed, no pollution or nuisance would be generated and the plant cover, as well as the natural habitats present on the right of way of the project site will not be affected. The situation of the receiving environment will be under the sole influence of its usual management method. Seen from this angle, the "without project" option will among other things avoid:

- loss of agricultural land (agricultural activities currently on the site);
- the abandonment of socio-economic activities (small trade);
- the deviation caused by the loss of the runway located in the site right-of-way;
- deforestation of the vegetation currently present on the site in an area poor in fauna and flora resources.
- Based on this analysis, the Malicounda thermal power plant project, in spite of its potential negative environmental and social impacts, is a necessity in order to optimize the means of electricity production with a lasting guarantee of the supply-demand balance of the interconnected network, as well as improving the living conditions of the population

However, it is noteworthy that the purpose of this study is to demonstrate that with the arrival of the power plant, there will be no significant change in the environmental characteristics of the project area through compliance with mitigation measures proposed under the ESMP for better protection of the peoples, the properties and the environment.

VI.3. SITE CHOICE AND LAYOUT ALTERNATIVES

The choice of site was mainly based on the proximity of a substation and the availability of land. Hence, the electrical connection distance is a determining factor in the selection of a power plant installation site. The total cable length is proportional to the loss of electrical production of heat. It is therefore essential to limit it as much as possible. In addition, it should be noted that the costs relating to the length of the underground cable are around 200 million for each kilometer of the route.

The feasibility of the electrical connection to the SENELEC network has been analyzed and it has been concluded that it is possible to connect this future power plant to the 225 kV substation located in the site right-of-way. This substation has the technical characteristics that allow the 120 MW planned for this project to be injected.

Several options were analyzed regarding the choice of the location of the various plant installations on the site's land hold. The following table characterizes the different variants studied.

Table 40 : Characteristics of various alternatives of the power plant installation location

Alternatives	Description of the alternative
Alternative 1	The production system is positioned on the western limit of the site. The chimneys are closer to the western boundary of the site. The fuel storage area occupies a central position within the site but is close to the northern limit of the site (112 m).
Alternative 2	The production system is located just behind the electrical substation and occupies a central position. The chimneys also occupy a central position. The fuel storage is located to the west of the site and is 320 m from the first settlements of Keur Maissa Faye.
Alternative 3	The production system is placed on the eastern limit. The chimneys are very close to the eastern limit, so the houses of Keur Maissa Faye. The fuel storage area is located near the western limit more precisely at North-west of the site.

To facilitate the comparison of these different variants, environmental and socio-economic parameters have been identified and grouped into five (05) sections, namely:

- noise pollution;
- dispersion of gaseous emissions;
- the effects associated with the risk of fire and explosion on populations;
- sensitivity linked to cultural heritage.
  To evaluate the variant, a score varying from 1 to 3 is assigned to each section depending on the importance of its negative impact: strong (3), medium (2) or weak (1). The following table summarizes the notes given to these headings according to the given location variant. The variant with the lowest cumulative points is the one with the least significant negative impact compared to the other two.

Table 41 : Comparison of the different emplacement alternatives

Studies parameters	**Alternative 1**	**Alternative 2**	**Alternative 3**
Noise pollution compared to first homes	1	2	3
Dispersion of gaseous emissions	2	2	3

Effects associated with the risk of fire and explosion on populations	2	1	1
Cultural heritage awareness	2	1	2
Accessibility of the administrative block, changing rooms and shops	1	1	3
Total	**7**	**6**	**9**

Choice of the optimal location

Alternative 2 combines the lowest cumulative points (6) according to the analysis of the different locations which could have a negative impact on the identified environmental and socio-economic components. This option is the most optimal in several respects:

- the impacts linked to the dispersion of gaseous effluents are mitigated. Indeed, the position of the chimneys located in the center of the site will allow a good dilution of the gaseous effluents and lower pollution levels at the limits of the power plant (east, west, north). Therefore, according to the results of the atmospheric dispersion study carried out by NUMTECH in annual average concentrations, the atmospheric fallout of the project is mainly towards the south, in accordance with the direction of the prevailing winds (coming from the north). The east and west directions are affected to a lesser extent. The north of the site has very little impact on an annual average.
- in this alternative, the fuel storage area is located more than 320 m far from homes of Keur Maissa Faye. The modeling of the consequences of a boil-over phenomenon and the determination of the various intermediate quantities, according to the methodology described in the INERIS report: 13, made it possible to conclude that the triggering time is estimated at two (02) days and three (03) hours. The maximum radius of the fireball would be 148 m. The irreversible, lethal and significant lethal effect distances are 260, 351 and 440 m.
- the power plant to be installed on approximately six (06) ha is located inside an 18 ha site. In addition, given the very low probability of the occurrence of the boil-over phenomenon, its fairly long trigger time allowing the organization of rescue and evacuation of human targets, the establishment of means of prevention, intervention and protection, the safety distance can be reduced to the radius of significant lethal effects (260 m). Thus, the choice of alternative 2 makes it possible to circumscribe the effect distance of 260 m in the grip of the 18 ha deliberated for the completion of the project and will not require relocation of the dwellings close to the site.

However, this storage area is close to the western limit of the power plant and therefore to the future toll highway. Building a firewall and respecting safety procedures seem to be a solution to avoid or, failing that, minimize the risks associated with this boil-over scenario. This option has been retained and materialized on the map below

Image Google Earth 3 : Retained alternative

Legend: Selected option/ power plant/location of the tank farm/limit of the site

VI.4. WATER SUPPLY ALTERNATIVES

The water consumption of the project during its different phases is a major issue from an environmental and socio-economic point of view.

The supply mode must be clearly defined to understand all the major potential impacts related to this choice.

The promoter has two options for supplying water:

- procurement from ASUFOR;
- supply from a borehole to be installed by the plant operator.
  These two (02) options are analyzed according to the consequences they imply during the development of the project on the environment and the socio-economic environment.

VI.4.1. WATER SUPPLY FROM ASUFOR

The village of Malicounda Wolof has a borehole managed by ASUFOR. This borehole must supply water to the various districts of the village and other surrounding districts (districts of Malicounda Serere).

This borehole, with a very wide coverage area, is currently marked by the drop in its pumping rate. In fact, in the initial state (1999-2000), its pumping rate which was 23.5 m3 / h has nowadays dropped to only 15 m3 / h. In other words, the exploited aquifer has lost productivity in this area and this situation explains the fact that in Malicounda Wolof, the rate of access to water is considered to be low. The frequent water cuts observed in the area reinforce this claim.

From a social point of view, connecting the plant to this borehole is almost impossible given the impacts that this option will have on the well-being and health of the populations who are beginning to decry these shortcomings in the water supply of the 'ASUFOR.

From an economic point of view, the costs linked to the connection and to the monthly invoices will have to be borne by the operator during the construction phase and throughout the operation phase of the plant. Knowing that the price per cubic meter (m3) for industrial connections revolves around 500 CFA francs, it will be necessary to provide each month with an amount of three million six hundred thousand (3,600,000) CFA francs, given the water needs of the power plant in the exploitation phase.

From an environmental point of view, the installation of the underground supply pipe will cause works that will disturb the soil and terrestrial ecosystems over a long distance (450 m) and probably compensation along the route and the grip of driving.

VI.4.2. WATER SUPPLY ON THE BASIS OF A BOREHOLE

The construction of a borehole for the project's water supply would make it self-sufficient to avoid competing with the population's drinking water. According to the results of the hydrogeological study carried out by the operator of the power plant, the productive aquifer of the Maastrichtian clay sands located at a depth of 240 m can be exploited. Indeed, this hydrogeological study made it possible to ensure the availability of the resource and the possibility of setting up this drilling without major consequences.

Despite a very low social impact, this option does not come without economic consequences. It is clear that the construction, management and maintenance of a borehole can also be costly for the operator of the power plant (each drilled meter is equivalent to 100,000 FCFA).

Although being relatively expensive, this option is more adequate since drilling wouldn't only guarantee the water autonomy of the plant. A specific disturbance of soils and terrestrial ecosystems will be observed, but it should be noted that it is possible to greatly reduce these impacts by providing the necessary investments and by carefully planning the works.

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VI.5. Site access alternatives

Access to the site of the plant is currently possible from national road 1 by taking the tarmac road which leads to Malicounda. The site is located 60 m from this road, right at the entrance to the village of Keur Maissa Faye.

It is noteworthy that it is a two-way road but rather narrow and very close to homes in places. It crosses the villages of Malicounda Serere, Malicounda Bambara and Malicounda Wolof.

It should be noted that the access of transport vehicles to the plant poses a real problem only during the construction phase. In fact, during operation, tank trucks transporting fuels (at the rate of 15 trucks per day), in addition to vehicles transporting the management and operating personnel of the plant (3 rotations per day) will be able to use the toll highway. These trucks will access the plant via the toll motorway interchange under construction and an exit is planned a few hundred meters from the project site which will avoid traffic risks

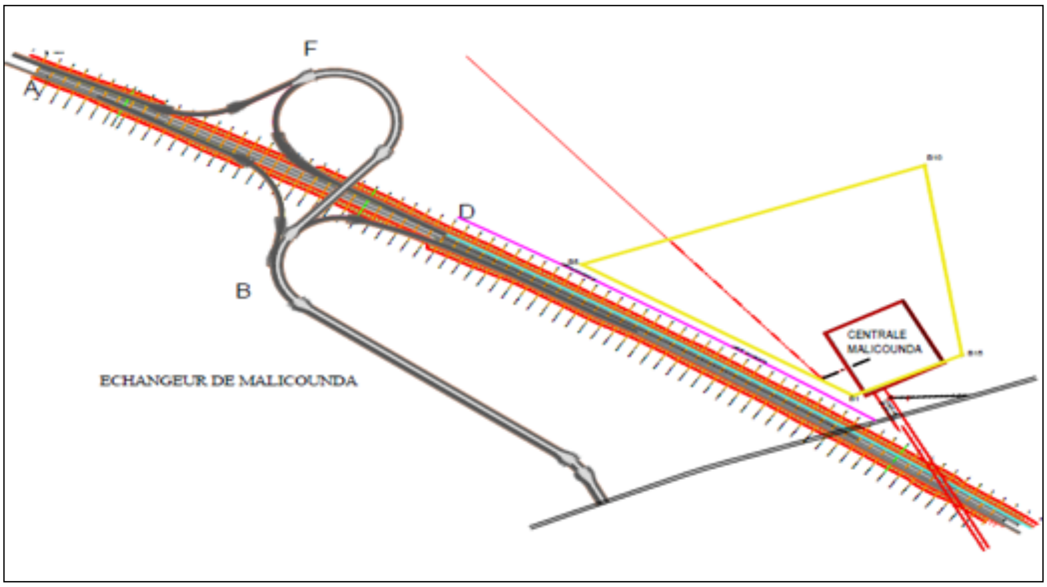

Figure 19 : AIDB toll highway layout Mbour, Malicounda
Source : Ageroute (coordonnées) et EES (traitement de données)

VI.5.1. Rehabilitation of the paved road alternative (power plant RN 1)

One option would be to widen this route to use it as an access to the plant site during the construction phase. In this case, vehicles could contribute to the deterioration of this road which is already in a bad state and requires repairing as soon as possible.

However, it should be noted that SENELEC has obtained an agreement with AGEROUTE for the use of an access road fitted out by the latter for the transport of large groups and equipment.

In other words, if the option of this tarmac road is maintained as an access route to the power plant, a slight increase in traffic will be observed. The latter would be linked to the crossing of trucks transporting the construction materials of the plant but also to vehicles transporting site personnel. The increased risk of accident is also an aspect to take into account.

It is also noteworthy that it emerged from the study on the characterization of air in the initial state carried out in September 2017, good air quality with pollution levels far below national and international standards that the project must maintain.

However, it appears that this option can cause emissions of pollutants, which could significantly contribute to an increase in the level of pollution in this semi-urban area.

From an economic point of view, this option will not create costs linked to the acquisition of land, rather those linked to widening and repairing the track will have to be borne by the authorized structures.

VI.5.2. Alternative of the realization of a ramp linking the power plant to the Diamniadio-Mbour road

For the implementation of this option, new land acquisitions are necessary as the new track to be built will cross over a good part of the fields belonging to the local populations. This alternative is shown in the image below.

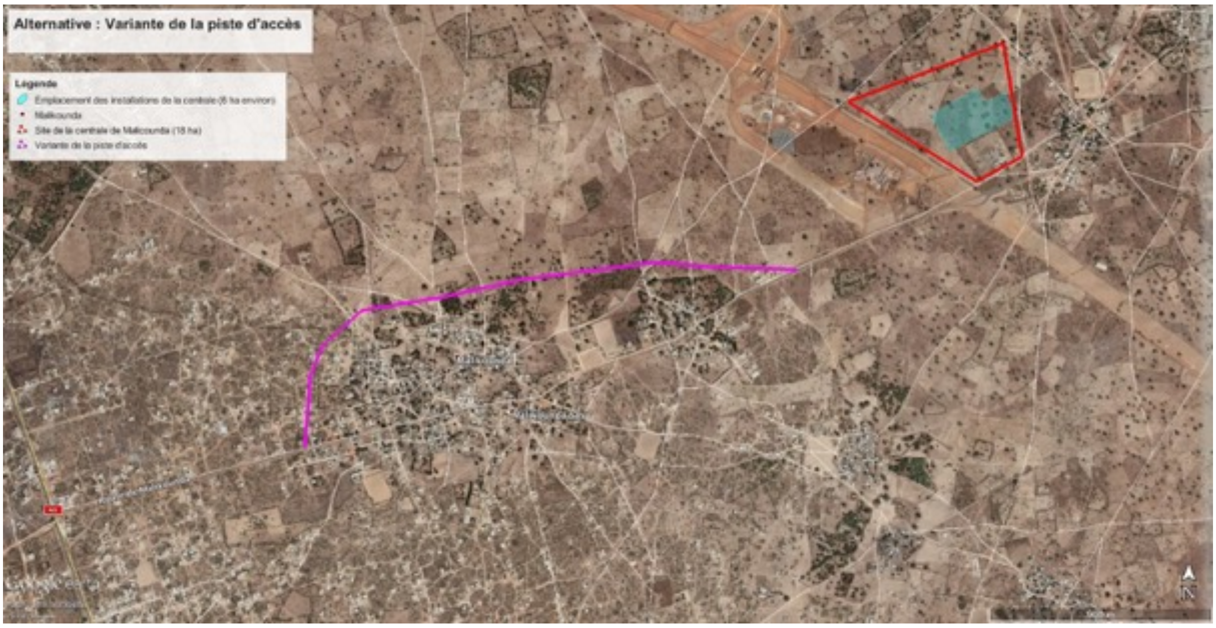

Image Google Earth 4 : Alternative representation of the new field

From a social point of view, the main impacts linked to this option constitute the loss of land and income. As compensatory measures, the study strongly recommends under these conditions to proceed to a just and equitable compensation and to respect all the procedure as well as the required authorizations by carrying out communication campaigns, by privileging the consultation with the affected people and the local populations.

From an environmental point of view, this option will impact the biophysical and human environments and mitigation measures should be suggested in order to reduce or avoid them as much as possible.

Finally, from an economic point of view, the construction of this track and the costs linked to the acquisition of land are much more expensive. But this alternative makes it possible to maintain the populations' health and their security as well as that of the users.

In light of this analysis, it seems that the construction of a new access road is the recommended alternative in the context of this study. Discussions are currently underway with all the stakeholders concerned to validate this option (SENELEC, Malicounda Power, Ageroute, SPE, (Permanent Secretariat for Energy).

VI.6. Technical Alternative

Nowadays, there are several technologies allowing the production of electrical energy. Within the framework of this study three (03) of these technologies were analyzed. They are as follows:

- a conventional diesel power plant operating on HFO;

- a conventional diesel power plant running on Diesel Oil;
- a coal-fired steam plant.

Criteria used to compare the different technologies are environmental, safe, sanitary, economic and operational. They are summarized as follows:

- **On the environmental level:**
  - Emission of Dangerous polluants (NOx, SOx, PM, etc.) ;
  - Sound emission;
  - Production of hazardous waste.
- **In terms of health and safety:**
  - Impact of atmospheric emissions on the health of populations;
  - Technological risks linked to the operation of the plant.
- **Economically and operationally:**
  - Net investment cost;
  - Occupation of space;
  - Time of completion of the plant;
  - Cooling system.

The results of the analysis according to the cited criteria are presented below. For each section, the possible alternatives were rated according to a high (H), moderate (M) or low (L) level; the "High" level "Being the least favorable and the "Low" level the most favorable.

Table 42 : Comparison of the different technological alternatives

Alternatives	ENVIRONMENTAL	RELATED SANITARY AND SECURITY-	ECONOMIC AND OPERATIONAL	QUOTATION
Conventional diesel power plant operating on HFO	- Pollutant releases (NOx, Sox, PM, etc.) within acceptable standards for current groups and when used of low sulfur HFO. - Significant noise emission which may be reduced by the soundproofing of the hall machines. - Hazardous waste consisting mainly of sludge from the centrifugation of fuel oil.	- Low health risks for populations if pollutant emissions remain within acceptable standards. - Occupational health and safety risks moderately high.	- Investment cost of around 80 billion. - This plant can occupy a small space. - Very short lead time (15 to 20 months) - Air cooler cooling system that does not require significant water consumption.	**M-M-L**
Natural gas-fired power plant	- Low emission of pollutants during combustion because the gas is a basically a clean fuel - Low production of waste from the process - Relatively large noise emissions	- Low health risks for populations because pollutant emissions stay within accepted limits. - Risks related to health and safety at work :moderately high	- Investment cost of around 50 billion - This plant can occupy a small space - Very short lead time (15 to 20 months). - Reduction in water consumption with cooling by air condenser	**L-M-L**
Coal-fired steam power plant	- Real air pollution problems (SO2 emissions often outside the norm) - Less noise emission - Waste problem consisting of ash from coal combustion	- Possible health risks for populations with exceeding emission limit values - Risks related to occupational health and safety: very important.	- Investment cost of around 107 billion- - This plant can occupy about 16 to 20 ha due to related facilities (coal stock, coal grinding and purification facilities, etc.) - Long lead time (24 to 30 months) - Cold source not existing for the open cycle condenser cooling (lake, river or sea).	**H-H-H**

Following this multi-criteria analysis, we could say that the option of a thermal power plant operating on HFO is the most optimal since its supply by Senstock remains possible unlike a supply of coal which would be made by boat and by imports. This option is also linked to high health and safety risks and will impact the host environment, in particular by air pollution due to emissions of various pollutants and greenhouse gases.

The gas option is very interesting from the point of view of the amount of investment. However, this fuel, although available in the Senegalese underground, is not yet exploited and its supply includes additional costs related to the importation and the setting up of pipelines. However, we would like to point out that the convertible gas-fired power plant may eventually make the transition as soon as the operation of the latter is effective. At the same time, this option will further minimize the risks associated with using HFO as a fuel.

VI.7. PROCESS CHOICE

The analysis of the different processes made it possible to highlight two (02) types of cycle, namely:

- the classical cycle;
- the combined cycle.

A conventional combustion turbine uses the calorific power of fossil resources to transform heat into electricity by means of a turbo-alternator. The fuel, mixed with pressurized air, is burned in the combustion chamber at a temperature of around 1300 ° C, causing a sudden increase in the temperature and pressure of the burnt gases. These gases then expand in the blades of the engine turbine, rotating around the same shaft as the alternator, which will generate electricity. At the outlet of the turbine, the still hot gases are discharged into the atmosphere. The efficiency of this type of process is not very high because a large part of the energy is lost in the form of heat in the exhaust gases.

Combined cycle power plants make use of the residual energy from these hot gases (575° C) which will transfer their heat in an exchanger to boil the fluid of a second cycle thermodynamics which takes place in the so-called "recovery" boiler. The steam thus obtained will in turn drive a second electricity-generating turbine. The advantage of these combined cycle power plants is therefore dual: the efficiency is greatly improved (up to 70% compared to 35% for a single cycle) and polluting emissions are greatly reduced (up to 50% d less polluting emissions for the same amount of supplied electricity).

In summary, we can confirm that from an economic, environmental and social point of view, the option of the combined cycle is chosen insofar as it favors a yield twice as high and significantly fewer polluting emissions despite an additional investment (boilers, condensers, etc.).

VI.8. CONCLUSION OF THE CHOSEN ALTERNATIVES

In the light of this analysis of variants on different aspects related to the development of the project, we could say that the best location on the site right of way corresponds to 2 variants (final version visible on lay out) with the installation of a combined cycle power plant running on heavy fuel oil FO2 and a water supply by a borehole which will be installed during the preparation phase of the works. In addition, the construction of a new access road is under study. This option will facilitate access to the power plant in complete safety and will maintain local residents' health.

VII. PUBLIC CONSULTATION AND INFORMATION DISSEMINATION

VII.1. Introduction

Public consultation is a component of the environmental and social impact study. Indeed, it is governed by the law on the Environment Code by ministerial decree No. 9468 MJEHP-DEEC dated November 28, 2001 regulating the participation of the public in the environmental impact study.

It must constitute a platform for exchanges in which all environmental issues arise and related projects. Thus, public consultation has the following specific objectives:

- to inform stakeholders about the plant construction and operation project 120 MW Malicounda thermal power plant by SENELEC;
- collect their opinions and concerns in relation to the project components, objectives, challenges and priorities;
- to collect the recommendations of the stakeholders whose application will allow better sustainability of the project in its host site;
- collect up-to-date data on the locality, the department and the region from the technical services of the State and local authorities which will enable the initial situation in the project area to be understood.

VII.2. Adopted Methodology

For the consultations planning, the EES cabinet has developed and followed a communication plan which aims at the good documentation of the preparatory phase of the public consultation. This communication plan consists of defining the approach for carrying out public consultations with stakeholders in carrying out the designated project.

It is about the identification of the concerned actors, the specific characteristics and sensitivities of the different localities which will be impacted by the project. The targeting of institutions and resource persons was limited to potential sites and PAPs as well as to members of the process structures for monitoring the environmental and social impacts of the project.

Essentially, it is the members of the National Technical Committee and the Regional Environmental Monitoring Committee who will have a decisive role in validating this environmental and social impact study.

After the identification of these actors, the EES Cabinet make sure to send, to each of the structures whose involvement was deemed relevant, a prior information letter on the project. With regard to the populations, the socio-economists will study the site in order to make a first meeting with the resource people designated by the communities.

These consultations allow a wide sharing of the ownership-acceptance of the Project with all the actors involved. They allow the environmental and social dimensions of the project and the sensitivities of all categories of actors representing human settlements (housing and/or economic activities), local elected officials and local authorities (administrations and technical services of the State) of the project reception area.

Different methods have been implemented to achieve the objectives assigned to the public consultation:

- individual meetings were held during meetings with the administrative authorities, the technical services of the State and the local communities concerned by the construction and operating project of Malicounda power plant;
- focus-groups organized for populations, neighborhood associations. For these categories of stakeholders, the floor was free and everyone could give their opinion by expressing their fears, expectations and recommendations on the project.
- In all cases, the meetings with all stakeholders were held as follows:
- presentation of the project;
- objectives of the environmental assessment and the need to actively involve stakeholders in the stages of the project assessment process;
- collection of questions, opinions, concerns and recommendations.
- These discussions made it possible to discuss the following points:
- the various components of the project during the construction and operation phases of Malicounda thermal power plant;
- the participation and involvement of all stakeholders in all phases of the project;
- taking into consideration the recommendations resulting from these consultations.

VII.3. List of Stakeholders

The list of stakeholders, the dates of the meetings and the number of people consulted are set out in the tables below.

Table 43: Consultation plan with the administrative and municipal authorities

Area	Structure	Place	Date DD/MM/YY	Number of present individuals
Region of Thiès	Governance of Thiès	Governance	11/07/2017	01
	ARD of Thiès	ARD Thiès	11/07/2017	01
Mbour Department	Prefect of Mbour	Prefecture	12/07/2017	01
	Sub-Prefect Sindia	S/prefecture	14/07/2017	01
	Departmental council of Mbour	Mbour	13/07/2017	01
Municipality of Malicounda	Municipal council	Malicounda	12/07/2017	01
Total municipal and administrative authorities				06

Table 44: Consultation plan of the state technical services and the national and regional level

Structure	place	Date DD/MM/YYYY	Number of present individuals
National level			
AGEROUTE	Point E Dakar	10/07/2017	02

Structure	place	Date DD/MM/YYYY	Number of present individuals
CRSE	Dakar	12/07/2017	01
Société Africaine de Raffinage-SAR	Mbao Dakar	14/07/2017	05
Evaluation Division of Environmental Impact	Directorate of Environment and Classified Establishments, Rue Carnot Dakar	31/07/2017	01
Pollution and Nuisance Prevention and Control Division		31/07/2017	01
Air Quality Management Center (CGQA)		26/07/2017	01
Directorate of Water Resources Management and Planning (DGPRE)	Camp Lat Dior Dakar	31/07/2017	01
Directorate of Civil Protection	Dakar	14/01/2017	01
Directorate of electricity	Petersen Dakar	14/01/2017	01
Total of the technical national services			**14**
Regional and departmental levels			
Regional Labor and Social Security Inspectorate	IRTSS Thiès	13/07/2017	01
DREEC of Thiès	DREEC Thiès	11/07/2017	01
Regional Service of territorial planning	Territorial planning in Thiès	11/07/2017	01
Regional Service of Sanitation of Thiès	Sanitation of Thiès	11/07/2017	01
Regional Service of Mines and Geology of Thiès	Mine and geology Thiès	12/07/2017	01
Departmental Service of town planning	Urbanism Mbour	12/07/2017	01
Regional Division of Hydraulics of Thiès	Hydraulics of Thiès	19/07/2017	01
Regional Agency of Development of Thiès;	ARD Thiès	11/07/2017	01
Regional Service of Statistics and Demography of Thiès	SRSD/ANSD Thiès	14/07/2017	01
Mbour Cadastral Office	Cadastral Mbour	12/07/2017	01
Mbour Hygiene Brigade	Hygiene service in Mbour	12/07/2017	01
Mbour firefighters	Mail exchange	17/07/2018	01

Structure	place	Date DD/MM/YYYY	Number of present individuals
Total consultations of technical services at regional and departmental levels			**12**

Table 45 : Table : Consultation plan with the riparian people

Date (DD/MM/YYY)	Village	Number of present individuals
10/07/2017	Malicounda Wolof	**28**
	Malicounda Serere	**51**
	Malicounda Bambara	**19**
23 /07/2018	Public meeting	**100**
Number of consulted individuals		**198**

The consultations took place from July 10, 2017 to July 23, 2018. It was therefore possible to reach 230 stakeholders distributed as follows:

- Administrative and municipal authorities: 06
- Technical services at national level: 14
- Technical services at regional and departmental level: 12
- Populations consulted in the three (03) villages located around the site: 198.

VII.4. PLANNING OF PUBLIC CONSULTATIONS

The public consultations took place in three (03) phases which are:

1- preparation and filing of preliminary information letters and making appointments;
2- meetings with the various targeted stakeholders;
3- the drafting of reports on exchanges carried out during public consultations and the drafting of the chapter on public consultations.

The schedule for carrying out the public consultations is detailed in the table below:

Table 46 : Planning of public consultations

Period / Activity	from 05 till 07July	from10 till 31 august	from 01 till 5 September 2017	23 July 2018
Preparation and mailing				
Meetings carried out				
Writing reports and chapter public consultations				
Public meeting update on the project in Malicounda				

Analysis of the table shows that most of the consultations were carried out during the year of 2017. In 2018, a debriefing meeting was organized by the Municipality

VII.5. PUBLIC CONSULTATION RESULTS

Following the successful conduct of public consultations, the results obtained can be broken down in terms of acceptability, formulation of fears, concerns, but also strong recommendations made by the administrative authorities and the technical services of the State, as well as the populations of the villages hosting and surrounding the project site.

VII.5.1. Project perception by the administrative authorities and the local elected representatives

Unanimously, the administrative authorities (Governor, Prefect, Sub-prefect, etc.), local elected officials welcomed the initiation of this project, and expressed their acceptance of the project and their willingness to get involved in its success.

The main concerns and major fears that emerged from the interviews are related to the presence of housing developments inside the site and the proximity of the dwellings to the future power plant. In relation to this, the recommendations made by the stakeholders are:

- clarify and resolve all problems related to land;
- take all the necessary measures to minimize the risks linked to the operation of the future power plant;
- take the example of the CSR policy of Malicounda solar power plant, which maintains good relations with the local community.

The following table is a summary of the public consultations.

Table 47 : Public consultation with the administrative authorities

Stakeholders	Reviews, fears and concerns	Recommendations
Governance of Thiès	It is a good project that we welcome.	- Take adequate measures to protect populations because transporting heavy fuel oil from Dakar to Malicounda can be dangerous; - Protect populations from any risk of fire and explosion; - Involve in the capital the town hall of Malicounda and the departmental council.
Prefecture de Mbour	- The most important at the department level is the involvement of all the technical services of the State to meet the expectations of the project; - This project is part of the emergency recovery plan for the electricity sector; - Each SENELEC project is saved in a program, like the ESSP (Energy Sector Support Plan).	- Get closer to the sub-prefect to facilitate the meeting with the populations; - Launch a good communication plan; - Inform the sub-prefect on the occupation of the site; - Solve the problem of discharging releases; - Solve the problem of land use.
Sub-prefecture of Sindia	- We note the presence of plots and traditional fields in the site to host the thermal power plant project. In addition, SENELEC had neither carried out the census survey nor paid the expenses before its implementation; - The owners of these plots have either established themselves irregularly without authorization, or have deliberative documents; - In Malicounda area there have been often land disputes because the traditional owners of the fields do not have administrative instruments, this is why it is imperative to carry out an investigation in order to make an inventory of fixtures in the project area; - The deliberation of SENELEC dates from 2012 and 2 years after a deliberation if the land is not valued or secured, a disaffection and an allocation may occur without the owner being informed; - This is why it is very likely that the people who are present in the area of SENELEC hold a deliberation, or are traditional owners of fields;	- Refer to the prefecture of Thiès which will in turn refer to the departmental commission for the assessment and inventory of expenses, for the compensation of people affected by the project; - Get closer to the president of the national commission of Malicounda; - Check whether the property titles of the people present on the site have been allocated before or after the deliberation of SENELEC; - Pay the compensations for the people affected by the project and who are within their rights or, propose an adequate compensation measure; - Secure the land with markup; - Take adequate security measures in the two phases of the project to ensure the safety of the

Stakeholders	Reviews, fears and concerns	Recommendations
	- Even if this plant is obsolete and expensive technology, it is to be welcomed if it increases electricity production performance while reducing both production costs and negative externalities to the environment.	populations because the power plant will be positioned in an urban environment.
Town hall of Malicounda	- The town hall holds 5% of the shares of the solar power plant located in the town; - Companies do not respect commitments and promises and especially in monitoring negative impacts; - The municipality has 22 villages, some of which are not electrified; - The coverage rate of access to water is still low in 3 villages from the communes: Saass, Ngoogom and Takhoum; The plots located on the site have no administrative acts;	- Set up a parameter monitoring system for population health; - Make a reference situation on existing diseases in the locality with the district doctor; - Reinforce the system of access of populations in favor of basic social services (water, electricity, education, etc.); - Provide shares in the company for the municipality; - Make an inventory of the plots located on the site; - - Consult the hydraulics department for the drilling
Departmental council of Mbour	- The project is a good initiative; - The Department Development Plan (PDD) is in the process of being developed; - The safety of populations with regard to the location of the site must be taken into consideration	- Promote the use of local non-qualified labor; - Carry out the affirmative action policy for positions requiring a qualification, an equal qualification in favor of nationals of the locality.

VII.5.2. PROJECT PERCEPTION BY THE TECHNICAL SERVICES

The main concerns raised by the various technical services of the State based at the departmental, regional and national levels, were oriented towards:

- aspects related to the safety of the plant, in particular the handling of dangerous products such as hydrocarbons, waste management and compliance with the safety perimeter;
- air pollution generated by the operation of the power plant;
- water management (operating water and wastewater);
- the recurrent issue of land, which marks its importance in the eyes of all categories of actors.

Faced with these major concerns, stakeholders made a number of recommendations, the most relevant of which:

- put in place the necessary arrangements to ensure the security of the plant;
- establish the baseline situation of the site (in terms of health, air quality, land tenure status);
- ensure compliance with the regulations in force relating to pollutant emissions;
- propose a good CSR policy, employ a qualified workforce and local employment.

The following table shows the results of public consultations with the technical services of the State.

Table 48: Consultation results with the technical services of the State

State technical services	Opinions, fears and concerns	Recommendations
Department of Environment and Classified Establishments (DEEC); Environmental Impact Assessment Division (DEIE);	- The safety aspects of the plant knowing that it will use a dangerous product, hydrocarbon, must be highlighted.	- Make models on atmospheric dispersions of emissions; - Take the appropriate measures to avoid fires in the storage tanks of hydrocarbons; - Define the reference situation for the water resource in order to know the impact of plant cooling on the resource; - Have the required authorizations from the hydraulic services; - Suggest good management of water resources by installing a device that allows water reuse; - Have the necessary authorizations for construction with the service of urban planning - Highlight all the impacts linked to civil engineering works (for the installation of new pylons if necessary); - Secure the site's land hold; - Present compensations to the PAPs and set up a good communication and awareness plan for the Medium Voltage and High Voltage lines; - Suggest a plant layout for its factory block; - - Emphasize on the study of dangers and propose a modeling on the distances of effects.
Department of Environment and Classified Establishments (DEEC); DCPN;	- The safety aspects of the future thermal power plant and the waste that will be generated by the future power plant must be taken into account.	- Secure the storage of fuels (hydrocarbons) and oils by ensuring good sealing of their retention and storage tank; - Ensure compliance with standard NS 05-061 before any wastewater discharge; - Ensure proper management of sludge from wastewater treatment; - Provide a device for purifying atmospheric discharges; - Set up a waste management system; - Ensure that the storage of diesels is far from ERP; - Set up a waste management system; - Respect the storage standards, ensure the compatibility of chemicals during their storage, ensure that the personnel in charge of these products is qualified and trained in their use and handling; - Hand over the used batteries (which will mainly be present in the control room) to approved companies for their recovery; - Set up a waste oil collection system to give them back to approved companies;

State technical services	Opinions, fears and concerns	Recommendations
		- Set up soundproof generator sets; - Provide and ensure the wearing of adequate PPE depending on the position of work; - Display the safety instructions.
Regional Division of Environment and Listed Establishments (DREEC) of Thiès	- it is essential to clarify the land status and to secure land tenure - if the project has difficulties in relation to its acceptability, it is essential to favor negotiation; - it is advised to take inspiration from the central solar energy especially in relation to aspects of CSR.	- Secure the land belonging to SENELEC, as well as the rights-of-way High Tensions; - Check the subdivisions and consider them as fields during negotiations for the payment of expenses; - Suggest the best technologies to limit pollution; - Internal monitoring of the environmental components likely to be impacted by the project and periodically inform the administration of the result of these follow-ups; - Determine the reference state of the site; - Sort the waste and put it in approved disposal channels; - Strictly monitor wastewater management, and see the possibilities for internal reuse of treated water and perform periodical measurements at rejection point; - Get closer to the hydraulics department and the DGPRE.
Mbour Hygiene Brigade	- The building authorization request must imperatively pass through the Mbour hygiene brigade for approval; - There is no sharp hygiene aspect to take into account as is the case of the food industries, but the health and safety of workers must be prioritized; - The wearing of PPE (leather gloves, glasses, safety shoes, boots ...) must be compulsory.	- Provide a pharmacy box (approach the district chief to find out about appropriate medications); - Install enough toilets (ten) and separate men's toilets from those of women’s toilets; - Provide English chairs for women's toilets for better convenience and ease of use with a flush and sinks; - Set up a health, safety and hygiene committee; - Plant ornamental species (approach the departmental water and forest service for appropriate species); - Recruit an occupational doctor; - Carry out medical visits before hiring and during the work of annual visits; - Raise awareness among populations on the dangers linked to electricity.

State technical services	Opinions, fears and concerns	Recommendations

Regional division of hydraulics	- There are two (02) aquifers in the area: The Paleocene which has a depth varying between 60 and 80 m and the Maastrichtian with a depth between 200 and 250 m (E.g.: The Malicounda drilling has a depth of 222.45 m; that of Fandane at 222.70 m); - In 2014, there were 38 standpipes and 18 community connections.	- Conduct a hydrogeological study to determine the quantity and the depth of the captured aquifer.
Thiès Regional Sanitation Service	- There is one WWTP in Mbour and another in Saly; - If the waters contain non-treatable substances and are very loaded, it is imperative to set up a WWTP; - It should be noted that the dimensions of a WWTP are determined from the volume of discharged water.	- Check if the central can connect to the Mbour STEP; - Provide a WWTP for the power plant or a lagoon system; - Provide toilets according to gender and take into consideration the people with reduced mobility and menstrual hygiene; - Set up toilets with boxes of 7 taking 5 people per toilet: the sanitation service has plans for construction and management model for these types of infrastructure; - Train staff on the sanitation ladder (teach them what to or what not to do).
Regional Planning Department of Thiès	- This project allows the diversification of the production areas which were concentrated in Tivaouane; - It also increases the energy potential which allows the development of economic activities; - It is an important step towards self-sufficiency energetic; - However, it raises fears related to the negative	- Take part in the local development effort; - Promote local employment.
Thiès Regional Development Agency	- In Malicounda there is a strong social tension linked to the land heritage; - Waste management remains a worrying question in a touristic area (Nianning, Pointe-Sarrène, Ngekhokh) and is close to Saly;	- Relocate the identified subdivisions to another compensation site, for the former owners; - Take into account the Malicounda solar power plant which gave a share of its capital to the municipality.
State technical services	**Opinions, fears and concerns**	**Recommendations**

	- However, if the local authority has a clear waste management policy, it could submit it to SENELEC in order to orient its CSR policy towards improving the living conditions of the populations.	
Regional Service of Thiès Statistics and Demography	- Electrical installations often do not respect the security parameters; - It is important to identify the potential impacts of the plant on its reception environment;	- Take into account the security parameter when designing the power plant; - Materialize this security parameter by markup; - Make the reference state on the health of local populations; - Check the possibilities of relocating the plant if the impacts are deemed to be very significant;
Mbour Cadastre Office	- It should be noted that the law of 1964 which governs National domain stipulates that after a period two years without development, an affected land can be decommissioned and reassigned; - However, for a reason of public utility the choice is made as the plant project; - The procedure should be sped up in order to secure the land acquired by deliberation.	- Make an inventory on the current situation of the site; - Approach the Cadastre to make an inventory of the encroached area; - Get closer to the national commission to be built on the issue of land occupation (subdivisions); - Materialize the property base with stakes, terminals or tables or fence the site with barbed wire; - Formulate a lease request at the Domain level and request the final session once the lease has been acquired.
Departmental service of Town Planning of Mbour	- The first concern is the presence of housing developments inside the site. Which is understandable because after two years if a site is not operated after deliberation, the code land allows its decommissioning and its reassignment to a third party; - But given the importance of the project, the plots may be relocated to another site;	- Find resettlement sites for landowners with the mayor's consent; - Take into account the negative externalities of the project and propose the adequate measures mitigation; - Secure the land by approaching the municipality and the STE; - Introduce the building authorization file; - Inquire about the situation of the subdivisions; - Obtain a lease title from the Domains office; - Make medical examination before hiring and every 6 months;
State technical services	**Opinions, fears and concerns**	**Recommendations**
	- SENELEC has an extract from the plan which is a cadastral document made by the land registry office. -He must initiate a procedure for securing the land.	- Raise awareness among the populations to the risks linked to the presence of the electric devices; - Get closer to the fire brigade.

Thiès Regional Labor and Social Security Inspectorate	- The establishment opening declaration is mandatory and must be accompanied at least by an employment contract - This declaration of establishment will allow the use of a Health Insurance Institution (IPM) for non-occupational diseases. - Declaration of worker movements (DMT) which allows you to join the Social Security Fund and IPRES. It is noteworthy that it is the fund that takes care of accidents at work and occupational diseases - If the company has more than 300 employees, it is required to create its own IPM - If the company has less than 300 employees, it has the possibility of joining an IPM among a multitude of structures - The employer has to pay the overtime hours beyond 40 hours per week with day or night-based rates, increased to 100% for rest days and public holidays - The employer has the obligation to organize the staff delegate elections from eleven (11) workers - The CHST is compulsory from 50 employees. This committee consists of 06 people including the company doctor. However, the inspector can	- -Establish an employer register composed of three (03) booklets. The third is reserved for the IRTSS; - Focus on health and safety at work and take all the necessary precautions to control the risks to which employees are exposed; - Train workers to prevent accidents at work and take into account the decrees of 2006 relating to the HSST committee and which sets the threshold for the establishment of this committee when the structure has at least fifty (50) workers; - Elect a staff representative regardless of the phase of the project as soon as the workforce is of eleven (11) employees; - Establish an occupational medicine and reconcile medical visits which may be done every six (06) months; - Establish employment contracts which must be written when it is a CDD or temporary contracts (interns, temporary workers, seasonal workers, etc.); - Set work schedules and provide day workers with pay slips
State technical services	Opinions, fears and concerns	Recommendations

	- The employment contracts must be written when it is a CDD or temporary contracts (interns, temporary workers, seasonal workers, etc.) - The pays lip is compulsory and must mention all wage headings (basic salary, overtime, tax and social deductions).It is noteworthy that the payment of wages is compulsory on the 08 of every month.	
Regional Department of Mines and Geology of Thiès	- The card presented in the information document is taken from Google which does not give a precision on the distance from the houses - The information document does not highlight all elements of the process - It was to provide an understanding of salient elements of the power plant - we can note the existence of dwellings and a road next to the site	- Control pollution and accidents - Develop a CSR policy - Present the plans of masses and situation - Contact the mining Cadastre in Dakar for the situation of authorized quarries in use in the locality; - These quarries must be 500 m from the dwelling. - Carry out a hydrogeological study before installing the borehole
Firefighters of Thiès	- Planning and supervision of the work must be done in order to ensure that the personnel have the knowledge, equipment and skills required to perform the installations and to work safely - The safety of the personnel is essential in the design, construction, operation and maintenance of the power plant. It is one of the fundamental aspects and must be a constant concern for the personnel and the company. - Security is also vital when it comes to mastering the job which leads to offering a qualitative	- Hold a classified installation type security register where all the technical verifications and the observations are noted by the safety commissions - Execute all work on the installations based on the principle of risk analysis - Ensure that the construction as well as the various fittings and installations fully comply with the texts in force - Establish a traffic plan in accordance with standards - Establish relief means proportional to the assessment of risks - Provide: 1- For firefighting (fire hydrant or hydrants, foam concentrate

State technical services	Opinions, fears and concerns	Recommendations
	- Equipment failure caused by poor maintenance can lead to serious consequences	- An evacuation plan - An intervention plan (hence the need to train staff)

Water Resources Management and Planning Directorate	- A study on technological variants concerning the use of water resources must be carried out, it will be able to provide information on the best device to put in place - The source of water supply for needs of the project must be specified - The selected source must guarantee both the viability of the project over time and the sustainability of the Resource - If the used water comes from ASUFOR, the project must give guarantees that the drilling can support both the needs of the plant but also those of the community - Malicounda will experience an extension of the area which will generate new urban centers, this is why new works are being carried out in the area by SONES to meet these new needs - Malicounda area has as its water table the Paleocene which is salty and the Maastrichtian which has fresh water, there are however surface water tables captured by the wells but which dry up at times during the year - In the construction phase of the plant, this won't be problematic, but during the operation of the plant, a significant amount of water will be needed.	- Quantify the daily water needs of the plant, and see how much works will be necessary to meet these needs - Decline the possibilities of using sea water for plant cooling needs - See the possibilities of using flood water after recycling it in order to improve the positive impacts on the environment - Process wastewater before discharge - Collect hydrogeological information from the area - Perform feasibility studies
Commission of Regulation	- License granting can be done following the impact studies	- Provide a good CSR policy, such as compensation, indemnities, etc.… - Solve the land problem because in this area, this problem is recurrent.

State technical services	Opinions, fears and concerns	Recommendations
The Electricity Sector	- The CRSE is an administrative authority independent which makes decisions that can only be reviewed at the Supreme Court - The Secretary General of CRSE encourages this kind of projects which help to meet demand in the country's electricity	

Direction of Electricity	- The project is relevant because it will strengthen capacities to meet needs and is part of the energy mix program - Gas use is expected by 2025, after the start of exploitation of gas discovered in Senegal - The project site is justified by the fact that Dakar is saturated and especially by its proximity to the generating station. - SENELEC does not have a production deficit for the moment, but it is necessary to anticipate the future needs. - According to SENELEC criterion n-2, if two plants fail, the rest should meet the needs of the population. - The rural electrification of the Mbour area is provided by a Tunisian electricity distribution company (STL), or SENELEC has already served certain areas of this region at lower prices. However, the state will ensure that tariffs are uniform through a compensation system.	- Ensure the autonomy of the power plant (10 days) in terms of storage of heavy fuel oil - Employ skilled workers - Thinking about a good CSR policy - Study the compass rose - Provide very high chimneys

VII.5.3. AT THE LEVEL OF CONCESSIONAIRES

The main Concessionaires met are AGEROUTE and Senstock. The choice was made for AGEROUTE because of the extension of the motorway to toll which will be near the site, while Senstock will be the fuel supplier of the future power plant.

The table below shows the exchanges made with the latter where the fears and concerns are set out, on the other hand some recommendations are formulated.

Table 49: Consultations with the concessionaires

Concessionaires	Opinions, fears and concerns	Recommendations
AGEROUTE	− The managers want to have the compass rose to know the orientation of the fumes from the power plant which may harm users of the toll highway − For this purpose, AGEROUTE intends to install four (4) boreholes − In the construction phase, good communication with the population and good coordination with existing companies will be necessary. − If the power lines have to go through the toll highway, they would have to be underground. − An interchange is planned in the Malicounda area. − The installation of the life base having already been made; construction works are essential.	− Communicate with the population during convoys for the transport of construction materials − Warning AGEROUTE and rolling out a communication plan for the transport of construction materials and the dismantling of walkways − Transport heavy materials preferably at night − Meet with the DGPRE to ensure that the water resources in this area will be sufficient for the creation of boreholes for AGEROUTE and for the power plant project, while taking into account the needs of the populations
African Refining Company	− The convoy of ten trucks carrying heavy fuel oil will be very dangerous and risky − Heavy fuel oil is a substance that freezes at room temperature, its storage requires special temperature conditions − The flash point of heavy fuel oil which corresponds to the temperature at which the fuel emits enough vapors to ignite in the presence of a heat source is around 70 ºC to 90 ºC − In case of an explosion, this could have impacts on neighboring villages or on neighboring roads; Explosions, fires, etc. are not the only possible accidents. There is also a risk of implosion of the storage bins. This is the only accident encountered at the RAD level.	− Promote storage bins instead of truck convoys; − Transport fuel with trucks equipped with adequate storage systems − Provide a safety distance between the storage bins, the installations and the roads − Heat the safety bins either with steam or with an electric heating system − Provide a good CSR policy, by creating infirmaries, schools… Use filters, to reduce gas emissions

Concessionaires	Opinions, fears and concerns	Recommendations
	− Implosion occurs when the pressure in the tank is lower than the pressure outside, and in the case of storage tanks, this phenomenon occurs following a blockage of the supplies; − In Senegal, Accident databases are almost non-existent; − The creation of instructions must be carried out by an expert having obtained his approval by Decree.	− Carry out different scenarios related to explosions, to predict the number and capacity of tanks − Store heavy fuel oil in fixed roof tanks with the help of a vent Employ qualified people − Train employees continuously − Inquire about all the information necessary when using the gas, because although they are less polluting, their use is more dangerous; − Create a hygiene committee; − Provide signals, fire alarms in the control panel.

VII.5.4. AT THE LEVEL OF THE LOCAL POPULATION

The majority of the populations of the three (03) encountered villages of Malicounda have a good acceptability of this project and magnify it. However, they fully express their concern about the non-compliance with the promises made by the promoters. They are ready to make their land available for new projects provided that the young people from the villages are employed for skilled and unskilled jobs. Moreover, the populations owning the land where the future power plant will be located were not made aware of the deliberation of their plots for the benefit of SENELEC. With regard to these numerous concerns, the populations have proposed recommendations, among which:

- carry out the identification and payment of expenses;
- suggest a good CSR policy by signing clear agreements with the legally based town hall for its application;
- recruit local employees for skilled and unskilled jobs;
- take into account the neighborhoods surrounding the power plant when establishing the bypass road.

The results of these consultations are available in the following table:

Table 50: Public consultations with the inhabitants of Malicounda Serere village

Villa	Opinions, fears and concerns about the project	Suggested recommendations by the population
The village of **Malicounda Sérére is** made up of four (04) districts (Malicounda Nguerigne, Malicounda Saass, Malicounda Ngoogom; Malicounda Ngoukhoudj, Malicounda Ndiadiam) **51 people were** consulted	− The presentation of the project to the populations is a great initiative to welcome; − Promises made by promoters are rarely kept, especially with regard to the employability of young people; − The area of the project site covers an area of 13 ha in the villages of Keur Maissa Faye in Malicounda Ouolof, Malicounda Nguerigne and affects a field in Malicounda Bamabara; − The landowners have not been informed of the deliberation of SENELEC which dates from 2012; − There was no compensation or census of PAP since then; − The populations must be informed about the constraints linked to the project in relation to the environment, to the population for breeding and agriculture; − Malicounda is a rapidly expanding commune, it is ready to receive all projects by making land available to promoters, but on condition that the young people of Malicounda are recruited for skilled and unskilled jobs. − This project is welcomed, the deliberation of SENELEC dates from 2012 and the parceling-out was carried out in 2016 the owners bought these lands; − The Municipality of Malicounda has enough land assets to accommodate new projects;	− Recruit the local workforce with equal qualification; in the construction phase and in the exploitation phase, even if it means training local populations among students − Invite young graduates from Malicounda to be employed in the plant; − Recruit in operation phase on the basis of results of aptitude tests of tests which will be followed by qualifying training; − Propose a recruitment quota for young people in the municipality for skilled and unskilled jobs; − train young people and women for the jobs to be filled; − Propose adequate security measures to preserve the environment, people close to the power plant, livestock and agriculture; − benefit from the benefits of the central to the municipality by payment taxes; − Improve the electrification of the municipality; it facilitates access to electricity by reducing the costs of electricity; or by offering the current; − Facilitate access to water (specifically the populations of Malicounda Ngongom and Malicounda Saass) by reducing the price of electricity for Assufor, which in turn will affect the price of m³ of water; − Respect the commitments and promises given to the populations and not follow the example of promoters who set up with their project and who do not keep their commitments; − Offer a market garden perimeter and installing a new borehole in the 18 ha planned for the power plant in order to support the populations; − Create a perimeter of negotiations between the town hall and the populations for the PAP compensation; − Provide clear contracts and insurance for future employees of the plant in the construction and operation phases; − Leave it to the town hall to negotiate compensation for the PAPs − Inform about the potential impact of power plants on the health of residents and workers; − Compensate the PAPs and avoid any social tension.

Table 51: Public consultations with the inhabitants of the Malicounda Bambara village

Vill	Opinions, fears and concerns about the project	Suggested recommendations by the
Village of **Malicounda Bambara** which is made up of ten (10) neighborhoods **19 people** were consulted	− This project is a source of pride for the municipality of Malicounda; − The first fear expressed is the air pollution which will emanate from the power plant; this smoke will accentuate the warming especially in Malicounda where it is very hot during the dry season; − The initiative to inform the populations about this project is welcomed; − This power plant will be the third to be established in the commune and the promises given by the promoters are rarely kept; − The majority of projects taking place in Malicounda are electric projects which represent a danger for residents and surrounding populations;	− Recruit the local population with equal qualification; − Take the necessary mitigation measures to avoid any danger and any impact on the population and the environment; − Train local young people for their qualification before their recruitment; − Reduce electricity costs and power cuts; − Suggest technical means to lower smoke emission from power plants; − Move the plant to another location where people will not be exposed to smoke;

Table 52: Public consultations with the inhabitants of the Malicounda Wolof village

Village	Opinions, fears and concerns about the project	Suggested recommendations by the population

The village of **Malicounda Wolof** consists of four (04) neighborhoods **28 people** were consulted	– The first observation is that the SENELEC site has been deliberated without a plan in 2012, thereafter there were a lot of plots inside this same site; – The site in question belonged to certain inhabitants of Malicounda who practice agriculture there, the deliberation of their land was made without their knowledge; – Therefore, there was no payment of expenses; Given the large number of power plants in the area of Malicounda the village of Malicounda Wolof more precisely the district of Keur Maissa Faye risk of disappearance; – The underground wires present in the Keur Maissa district which connect the power plants already on site and the transformer station raise concerns for the populations of Keur Maissa Faye, to this is added the establishment of this new power plant;	– Proceed to the payment of PAP expenses Do not apply the State scale when paying the expenses of PAP; – Rely on the estimation of compensation on a yearly report of farming over 25 years (duration of plant life); – Compensate the PAP for the 02 ha already used by SENELEC for the establishment of the generating station; – Respect the distance of 500 m which must separate the power plant from first dwellings; – Sign an agreement with the town hall to create a local recruitment committee; – Sign clear agreements with the legally based town hall for the application of the CSR policy; – Provide enough electricity for the Municipality of Malicounda and no longer experiences load shedding;
Village	Opinions, fears and concerns about the project	Suggested recommendations by the population

	The upsurge in power plants causes a problem for the Malicounda populations, because during winter, vibrations come out of the ground, and there are sparks in the overhead lines; Beyond the payment of expenses, the promoter must support the populations in the realization of community projects, and following this, the town hall has the right to vote after him.	- Invest within the framework of the CSR policy, in social projects, in setting up a health center, with qualified doctors, and a good technical platform; - Build schools and high schools to strengthen education; - Support the women's group with land donations to support small businesses or set up fruits and vegetables processing units; - Strengthen existing drilling by installing a new drilling; - Participate with the town hall in the maintenance of roads so that they comply with the standards; - Support mosques and Daarras (Koranic schools) by donating equipment (radios, carpets, etc.) or by renovating old ones; - Project of films to explain the mode of operation of the plant in order to raise awareness of the dangers linked to the operation; - Suggest adequate mitigation measures to limit the potential impacts of the plant on health; - Have the populations of Malicounda, especially the PAPs benefit from a reduction in the cost of electricity;

VII.5.4.1. PUBLIC MEETING WITH THE MALICOUNDA POPULATION

Analysis of Table 36 in relation to the Planning for carrying out public consultations indicates that most of the consultations were carried out in 2017.

In 2018, the data changed with the dissemination of false information about the project which ended up sowing doubt and modified the perception of the project by the local populations. The population proceeded by expressing many fears related to the potential impacts of the project on their general health and their life expectancy and ended by concluding that thermal power plants are dangerous and cannot coexist with the populations. This situation created a division within the population, part of which became reluctant and against the implementation of the project.

In order to clarify this situation created by supposed opponents of the mayor, a meeting was made by the Municipality of Malicounda to the public municipality. This meeting brought together more than a hundred people, made up of representatives of the three villages that met during the 2017 consultations and the following structures and authorities:

- Sindia sub-prefecture;
- The Municipality of Malicounda (the mayor and his assistants);
- Malicounda municipal council;
- SENELEC;
- The EES Cabinet;
- The Commander of the Mbour police.

SENELEC representatives said during their speech that this project is eagerly awaited as it will allow access to energy in sufficient quantities to present remedy to the production deficit and that the area is well chosen because it already has an electrical substation. SENELEC will also ensure that the suggested mitigation measures in the study are rigorously applied.

The administrative and local authorities have focused their intervention on the fact that this national project represents an interest for all the citizens of this country and affirm that they are more responsible than anyone for the health of populations and their safety and that 'They will never validate a project that affects their well-being".

The representatives of the EES Cabinet intervened to explain that any project has a socio-economic and environmental impact and to highlight the major impacts of the project, whether positive or negative. They mainly insisted on the mitigation measures which will be defined in the ESIA report and which should result in the implementation of the Environmental and Social Management Plan which is the outcome of the study. These measures, aimed at reducing or even eliminating the impacts of the project, will become laws and shall be applied as soon as the document is validated by the ministry in charge of the environment. Among these measures:

- Establishment of a security perimeter around the power plant which will require the release of a right of way which will be defined by the Study of Dangers;
- Use of latest generation equipment and good quality fuel.
- Developing and implementing a Resettlement Action Plan (RAP) for fair and equitable compensation of the owners identified on the 18 ha and the security perimeter.

To conclude, the Cabinet recalled that the final call remains that of the local population which will have to decide on the final validation of the project during the public hearing which will be organized with them. This decisive step will allow the release of the environmental discharge for the effective start of construction works or the blocking of the procedure for obtaining the building permit to go to negotiations in order to reconcile between all the parties interested in the project.

Following these interventions, the populations acclaimed their approval for the project to follow the procedure initiated and wait to see the results of the study for final validation during the public hearing.

VII.6. ANSWERS OF THE CONSULTANT AND THE PROMOTOR

VII.6.1. OVERVIEW OF THE ADDRESSED THEMES DURING CONSULTATIONS WITH STAKEHOLDERS

The six (06) themes described below are the major points noted during the discussions resulting from the public consultations with the various stakeholders in the project:

- Land acquisition and compensation;
- Local employment and training;
- Environmental and social impacts, risk management;
- Communication and mediation around the project;
- CSR and compliance with commitments made;
- Financial benefits for the municipality.

The results of the public consultations reveal that with the exception of a few, the same concerns were raised practically by everyone consulted.
Below are the various themes raised by the populations and other consulted stakeholders (technical services, administrative and municipal authorities) are developed, as well as the actions carried out or planned by the project to provide answers and solutions to these concerns.

VII.6.2. MAJOR CONCERNS OF THE POPULATIONS AND ANSWERS OF THE PROJECT

VII.6.2.1. LAND ACQUISITION AND COMPENSATION

Some populations were expropriated from their land for the needs of the project. They did not appreciate the lack of consultation and information on the municipal deliberation of 2012 which grants the site to SENELEC. However, they welcome the opportunity to correct this communication problem through their consultation as part of this impact study.

A Departmental Commission for the Census and Assessment of Expenses (CDREI) under the authority of the Prefect has already been mobilized to identify the people affected with a view to drawing up a PAR to compensate them.

VII.6.2.2. LOCAL EMPLOYMENT AND TRAINING

These two (02) themes were mentioned by almost all of the stakeholders. The authorities of the territorial administration, the persons in charge of the technical services of the State as well as the populations recalled the need to favor the recruitment of the indigenous populations at all stages of the project.
The project provides 400 jobs in the construction phase and 50 in the operation phase. The study recommends giving priority to local employment with equal skills and encouraging the recruitment of local populations, especially people with low incomes for unskilled jobs (local labor, cleaning, security, etc.) and ensuring their ongoing education.

For this matter, it was recommended to set up a local staff recruitment committee made up of representatives of the municipality, from different sections of the population (men, women, young people, technicians and specialized workers from the project area). The results of the work of this commission will be validated by the sub-prefect before their transmission to the promoter or recruitment agency designated by the latter.

In any event, recruitment should be done as far as possible in the municipality of Malicounda and the surrounding localities. In the interests of fairness and bearing in mind that this is a regional project, part of the jobs can be reserved in Malicounda, part in the other surrounding localities.

VII.6.2.3. ENVIRONMENTAL AND SOCIAL IMPACTS, RISK MANAGEMENT

It is important to identify the potential impacts of the plant on its reception environment. All categories of stakeholders returned to this recommendation. The promoters (SENELEC and the operator of the power plant) are required to comply with the legislative and regulatory provisions relating to the protection of the environment of the receiving environment of the project and of local residents on all the negative impacts generated by the project.

The results of the impact analysis as well as those of the technological risk analysis will allow the operator of the power plant to become aware of the main impacts of the project on the various receiving environments and above all the means of avoiding and mitigating them, or to intervene in case of an accident.

The study recommends the execution of all the recommendations inherent in the management of impacts and the prevention of risks related to project activities. The project team has already taken the lead in integrating, following the results of the hazard study, the safety distance necessary to contain the probable disaster effects in the total area requested for the needs of the project.

The development of a waste management plan and a risk management plan are also strong recommendations from the study.

VII.6.2.4. COMMUNICATION AND MEDIATION ABOUT THE PROJECT

The populations ask to be informed about the impact of the project on the environment, on the start-up and the different stages of the project.

For this purpose, the study recommends that regular meetings be held with them to raise awareness of the various risks linked to projects and good attitudes, the reflex actions to be adopted to avoid any accidents.

It is also advised to make available a notebook of grievances and grievance cards and to make a serious and regular follow-up of the complaints of the populations in order to aspire, to a good cohabitation, with the populations and to avoid disturbing their surroundings as much as possible.

It will be essential to establish a communication plan with AGEROUTE for good management of transportation both in the construction phase (construction materials and equipment taking into account the height of the bridges and walkways that will be crossed). This schedule must be regularly updated, especially in the operating phase with the frequent circulation of service vehicles and tank trucks transporting the fuel necessary for the operation of the Plant.

The information in this schedule on the passage of convoys for the transport of construction materials will be regularly transmitted to the town hall of Malicounda for information and display. In view of its great sensitivity, the release of the land made available to the project will be the subject of a rigorous communication plan punctuated by iterative meetings until compensation for the PAPs which constitute the final result of the work of the departmental commission of evaluation and inventory of expenses, for the compensation of people affected by the project (CDREI). In addition, the drafting of the Agreement between the City of Malicounda and the promoter will require a communication plan that is carefully monitored.

VII.6.2.5. FINANCIAL BENEFITS

The establishment of a power plant in Malicounda generates direct financial benefits for the City Council. The project is subject to the payment of the land contributions and the payment of the Local Economic Contribution (LEC) and of the added and rental value (VAL). Moreover, it should also benefit from the advantages attributed by the Investment Code, to which it is eligible.

The tax benefits of this project will be located at two (02) levels:

- **During the construction phase**

Purchases of goods and services for the construction of Malicounda power plant will generate payments for Value Added Taxes (VAT) borne by purchases of construction materials.

These taxes are directly paid through the sale prices of goods and services. The municipality of Malicounda will be required to collect taxes and charges, in particular the tax on household waste (TOM) in order to be able to provide its services when collecting the various waste generated on the construction site of the plant. It is very important to underline that the revenue of the municipality is mainly composed of these fees, local taxes and received subsidies.

In addition, the employer must automatically deduct workers' contributions from compulsory or authorized social welfare institutions, under the conditions set by the regulations in force or by the statutes of these institutions.

- **During the exploitation process**

These are local taxes, various royalties including taxes collected sustainably by the Municipality of Malicounda for the duration of the operation of the power plant.

Social security contributions paid for the benefit of workers, local taxes and other fees paid by providers of fuel and lubricants necessary for the operation of the plant. The outsourcing of periodic maintenance services for its equipment and premises as well as the disposal of various waste (solid and liquid) are all sources of direct and indirect tax revenue.

VII.6.2.6. CSR PROGRAM

Corporate Social Responsibility (CSR) is understood here in the sense of actions for the benefit of the community that the promoter will undertake concomitantly with the operation of the power plant. The promoter will have a well-defined CSR policy, based on the expectations of the local community and the population. He can orient himself according to his sensitivity and his CSR budget according to the development priorities of the municipality or towards:

- the health sector:
  - by renovating the existing health post;
- the education sector:
  - by renovating existing classrooms
  - by donating school supplies or materials
- the social aspect:
  - by supporting women to have market gardening to strengthen their financial autonomy and improve the nutrition of all sections of the population;
- Rural electrification:
  - Connect the non-electrified village to the SENELEC network.

All these actions will promote better integration of Malicounda thermal power plant in its host environment. The implementation of the CSR policy will be left to the promoter's discretion.

However, it should be noted that the latter must sign a memorandum of understanding with the municipality to respect any commitment made to the population.

VII.7. Conclusion on the public consultations

As part of these public consultations, the firm's approach consisted in organizing meetings with the concerned stakeholders in order not only to inform them of the advent of the project but also to exchange with them and gather their opinion, fears but especially their recommendations with a view to taking them into account during the implementation of the project.

Following the various meetings carried out that the project was acceptable and which, at its time, strengthens the country's energy fabric. However, the question related to land, which has come up several times and was raised by all stakeholders (administrative authorities, local populations), shows how much of a concern it is, and its resolution is essential for the success of this project.

In July 2018, SENELEC initiated the implementation of the RAP which will allow it to identify the PAPs and assess the compensation. Payment will be made in accordance with the texts and regulations in force in Senegal and the requirements of the AfDB.

Safety and air pollutant emissions linked to the operation of the power plant were also points on which the stakeholders dwelled, faced with this the recommendation issued and, to comply with the regulations in force.

VII.8. Orientations of the stakeholder engagement plan

VII.8.1. Community relations policy

The Project must work for a good management of its relations with the communities in order to establish better integration in the host locality.

To do this, a good communication policy must be established, suggest an advantageous social development program, and have a locally oriented recruitment and purchasing policy.

The communities directly affected by the project must be given priority in the face of the social actions undertaken by the project. The latter must hold a sincere and open discourse with the affected populations in order to avoid any risk of social tensions, disputes or damage to the reputation of society.

Saving a good community relations management policy is an approach which must be undertaken during the entire life of the plant.

VII.8.2. Human resources management policy

The promoter must have in its procedures, an internal human resources management policy, in accordance with the Labor Code in force and must relate to the following aspects:

- Prerequisite before starting any activity:
    - provide the IRTSS with the declaration of establishment of the company and the declaration of the worker's movements;
    - this declaration of establishment will make it possible to have recourse to a

Provident Institution
Sickness (IPM) for non-occupational diseases;
    - the Declaration of Worker Movements (DMT) which allows you to join the Social Security Fund and IPRES;
    - types of contracts must also be reported to the IRTSS;
- Human resources policy and procedures:
    - set up internal regulations which must be validated by the labor inspector and must revert to the general working conditions (hours, discipline, safety measures);
    - set up a clear and accessible communication system for all workers of the company;
- Working conditions:
    - respect the collective agreements that govern the electricity sector;
    - improve working conditions by respecting the rules of hygiene, health and safety at work;
- Terms of employment and equal opportunities and gender:
    - protect contract and temporary workers;
    - avoid any discriminatory policy when hiring;
    - avoid harassment from management or higher level employees;
    - avoid forced labor;
    - prohibit work by minors;
    - extend work policies to suppliers, recruitment agencies and other third parties;
    - develop grievance mechanisms for workers.

This human resource management policy suggested to the project company can be improved but must necessarily be communicated to the staff.

VII.8.3. INFORMATION AND COMMUNICATION TOOLS WITH STAKEHOLDERS

The stakeholder engagement plan is an ongoing process that must be undertaken before the start of the construction phase and throughout the operation phase of the project.

Different methods can be used to inform stakeholders of the ongoing engagement process to be undertaken by the project. These will be standard methods including newsletters, posters and monthly briefings.

When it comes to stakeholders such as administrative and local authorities, technical agencies and public agencies, communication will be done by official mail.

Likewise, the letters will also be used when it comes to informing them of the mechanisms of engagement and dissemination of information during construction as well as the operational phase of the project.

For stakeholders located at the local level (communities affected by the project), illustrative signs and posters in the form of a monthly information letter will be placed on billboards in each concerned place (public square in the neighborhood / village, schools, mosques, prefecture, sub-prefecture and town hall) in order to inform the concerned stakeholders about the mechanisms of engagement and dissemination of information.

During the construction phase of the project, the installation of signage will also make it possible to inform the population about the key activities that could affect them (for example, starting work, transporting equipment to the site, the number of jobs created, etc.).

VII.8.4. INFORMATION DISSEMINATION TECHNIQUES

To provide all stakeholders with complete, accurate and understandable information, the promoter could organize regular meetings.

In addition to letters sent frequently to stakeholders, periodic meetings with all identified stakeholders will be organized. The administrative authorities, local elected representatives, representatives of local populations and members of the Regional Environmental Monitoring Committee will be associated with these meetings.

The agenda will be established with the participation of local populations in order to integrate and discuss all the points raised. The minutes of these meetings will be published and accessible to all stakeholders.

The topics that will be discussed, among others, with stakeholders during these meetings are listed below:

- the purpose, nature and scope of the project;
- monitoring of commitments made by the promoter;
- the duration of project activities (construction phase and operation phase);
- the risks and potential impacts identified as well as the mitigation measures proposed;
- the stakeholder engagement process;
- the grievance mechanism.

This list is not exhaustive.

In addition to these periodic meetings, regular information, awareness-raising and internal training sessions on hygiene, health and safety as well as the implementation of the various plans (POI, PPI) must be provided by the project company.

VII.8.5. GRIEVANCE MECHANISM WITH WORKERS AND COMMUNITIES

It will provide a mechanism to receive and respond appropriately to complaints and concerns related to project activities in a time acceptable to stakeholders.

Complaints can come from various sources (land appropriation, use of local labor, environmental problems, failure to meet expectations).

Thus, these complaints can be classified according to the following criteria:

- land litigation;
- type of procedure;
- complaints involving contract workers;
- environmental and social performance;
- cultural issues;
- behavior of staff working on site;
- lack of information and communication on the project.

VII.8.5.1. RECEIPT AND RECORDING OF CLAIMS AND COMPLAINTS

The promoter may make available to the community grievance books or forms for the filing of any complaints or grievances. These forms and notebooks of complaints will be deposited at the level of the municipality. They may also be deposited at the prefecture and the sub-prefecture.

For workers, grievance sheets will be made available, as well as a grievance book. When a complaint is made, the complainant (identified) receives an acknowledgment of receipt. Those who cannot complete the grievance booklet can present their complaint verbally to the team responsible for receiving complaints, which will complete the book of complaints and a witness copy bearing acknowledgment of receipt and stamp of the team leader will be given to them.

VII.8.5.2. TREATMENT OF COMPLAINTS

As defined in the above paragraphs, the promoter must put in place a team that will be in charge of implementing the grievance mechanism. It will be the first receiver of complaints and their treatment.

Any complaint received is recorded in the complaint register and a complaint follow-up form is opened. In this form, the actions taken to deal with the complaint must be mentioned (chronology of treatment and suggested solutions).

The register must include at least:

- date of receipt of the complaint;
- name of the person who received the complaint;
- address and contact of the complainant;
- the complaint;
- the resolution schedule (start and end of the execution of the corrective action);
- date the complaint was resolved;
- date of notification to the complainant.

VII.8.6. PROJECT CSR POLICY

The Project must have a well-defined CSR policy, based on the expectations of the local community and the population.

For the success of this social responsibility approach, it is necessary to have a good knowledge of these expectations which are largely underlined in the municipal development plan of the Municipality of Malicounda.

SENELEC, in conjunction with the Project Company, can therefore undertake community actions guided by the priorities set out in this PDC which affects all sectors of activity.

- build a maternity unit in Malicounda health post;
- provide Malicounda health post with an ambulance;
- support the municipality in setting up a controlled public landfill;
- strengthen the electricity network in certain localities and villages that are not yet electrified.
- support women processors of fishery products by donating modern processing equipment (solar ovens for example);
- participate financially at the commune level in the road maintenance program and tracks set up;
- provide the town with a technical and vocational training center equipped for girls;
- provide elementary schools with teaching materials and equipment
- build hygiene blocks for toilets in schools;
- enclosure walls.

This CSR program will be discussed and deepened by all parties before the start of work (SENELEC, Malicounda Power, Prefect, Sub-Prefect, Town Hall, Local populations, etc.). An annual budget will be allocated for these social activities.

VIII. ANALYSIS OF ENVIRONMENTAL AND SOCIAL IMPACTS

VIII.1. METHODOLOGY AND EVALUATION LIMITS

This chapter presents the assessment of the positive and negative impacts of the project, during the construction and operation phases of Malicounda power plant, on human, biophysical and socio-economic environment.

The various points covered in this section are the identification of the direct, indirect, temporary and permanent effects of the project on the receiving environment as well as the identification of socio-economic impacts and the proposal of mitigation or improvement measures depending on the nature of impact.

The environmental management and monitoring plan to minimize the residual impacts and ensure effective monitoring of the components likely to be affected by the project is presented in Chapter X of this report.

VIII.1.1. PRESENTATION OF THE ENVIRONMENTAL COMPONENTS

The environmental components likely to be affected by the project are divided into three (03) categories according to their nature, titled "important elements of the environment" and consist of:

- the physical components:
  - air quality;
  - soil quality;
  - the quality of surface and groundwater;
- the biological components:
  - fauna and avifauna;
  - wildlife habitats;
  - special status species;
  - terrestrial vegetation;
- human components:
  - socio-demographic characteristics;
  - economic activities;
  - land use and exploitation;
  - public infrastructure and equipment;
  - the archaeological and cultural heritage;
  - public health;
  - the living environment including public security, the landscape, the sound environment.

These environmental components will be impacted during the course of the project by activities that are presented in the following paragraph.

VIII.1.2. PRESENTATION OF SOURCES OF IMPACT

The activities related to the construction and operation of Malicounda thermal power plant which are likely to generate positive and negative impacts on the various environmental components are:

- During the construction phase:
  - the release of the right of way (weeding, deforestation of the site, etc.);
  - the development of access roads to the site;
  - the routing and storage of building materials and materials;
  - mechanical and manual handling of equipment;
  - traffic in and around the site;
  - earthworks and excavation;

    - construction work;
    - the use of water;
    - generation and management of waste;
    - the creation of jobs;
    - the purchase of goods and services.
- **In the operating phase:**
    - the daily activities of the occupants of the power plant and its dependencies;
    - the operation of the generator sets;
    - transportation, delivery and storage of fuels;
    - traffic inside the site;
    - work organization;
    - the atmosphere in the site;
    - generation and management of waste;
    - the creation of jobs;
    - the purchase of goods and services.

In order to know the environmental components that will be impacted by each type of activity, the sources of impact will be reported in a double-entry table called "Leopold matrix" whose primary function is to allow the identification of potential impacts on the various environmental components. The matrix is presented below.

Table 53 : Interaction matrix sources of important-impact elements of the environment

Important elements / **Impact-generating activities**		**Air Quality**	**Soil Quality**	**Quality of superficial and underground waters**	**Terrestrial fauna**	**Particular species**	**Avifauna**	**Terrestrial vegetation**	**Socio-demographic characteristics**	**Economic activities**	**Land use and exploitation**	**Infrastructures and public equipment**	**Archaeological and cultural heritage**	**Public health**	**Life context**
Construction Phase	Weeding and deforestation of the site	■	■	■	■	■	■	■			■				
	Development of access roads to site	■	■	■	■	■	■	■			■			■	■
	Routing and storage of construction materials	■	■	■						■		■		■	■
	Mechanical and manual handling equipment		■	■	■	■	■	■							
	Traffic on the site and its surroundings	■	■	■	■	■	■	■						■	■
	Land work and excavation	■	■	■	■			■						■	■
	Construction work	■	■	■	■		■	■		■				■	■
	Water usage			■											
	Waste generation and management		■	■	■									■	■
	Creation of jobs								■	■					■
	Purchase of goods and services								■	■					■
Exploitation Phase	Activities in the station	■	■	■	■		■			■				■	■
	Operation of groups generators	■	■	■	■		■							■	■
	Transport, delivery and storage of fuels	■	■	■										■	
	Atmosphere inside the site													■	■
	Waste generation and management	■	■	■										■	■
	Creation of jobs								■	■					■
	Purchase of goods and services								■	■					■

VIII.1.3. EVALUATION PROCESS

When all of the potential impacts of the project on the socio-economic environmental component were identified, the significance of the foreseeable modifications of this component is assessed. The procedure and the evaluation grid for the significance of the effect are succinctly given in the following paragraphs.

The methodological approach used to assess the environmental impacts of the project is essentially based on the assessment of the intensity, extent and duration of the anticipated impact. These three (03) qualifiers are aggregated into a summary indicator; the importance of the impact, which makes it possible to make an overall qualitative judgment on the anticipated effects for a component following an intervention on the environment.

The significance of the impacts will be assessed on the basis of the following criteria:

- the intensity;
- the duration;
- the extent.

VIII.1.3.1. INTENSITY

The intensity of the impact defines the extent of the changes disrupting the integrity, function and use of each of the components of the environment affected by the project. It is obtained by crossing **the magnitude of the disturbance with the value given to the environmental component** impacted.

The intensity of the environmental impact varies from very high to low and results from the combination of the factor assigned to the degree of disturbance and that assigned to the value of the component. The following table shows the different possible combinations.

Table 54 : Matrix of determination of the impact's intensity

Disturbance degree	**Component Value**		
	High	Moderate	Low
High	Very high	High	Moderate
Moderate	High	Moderate	Low
Low	Moderate	Low	Low

VIII.1.3.1.1. Degree of disturbance

The **degree of disturbance** of a component defines the extent of the structural and functional changes it is likely to undergo. It depends on the sensitivity of the component with regard to the suggested interventions.

Changes can be positive or negative, direct or indirect. The degree of disturbance is judged:

- **high,** when the intended effect calls into question the integrity of the component or strongly and irreversibly modifies this component or the use made of it;
- **moderate,** when the effect leads to a reduction or an increase in the quality or affects the use of the component without compromising its integrity;
- **low,** when the effect modifies the quality, use or integrity of the component only in a noticeable way;
- **undetermined,** when it is impossible to predict how or to what degree the component will be affected. When the degree of disturbance is not determined, the assessment of the environmental effect cannot be carried out for this component.

VIII.1.3.1.2. Value on the environmental component

The value of the component includes both its ecosystem value and its socio-economic value.

The ecosystem value of a given component is considered to be:

- **high**, when the component is of major interest because of its ecosystem role, its diversity and its exceptional qualities, namely the conservation and protection of which are the subject of consensus in the scientific community;
- **moderate**, when the component is of great interest and has recognized qualities, the conservation and protection of which represent a subject of concern without, however, being the subject of a consensus;
- **low,** when the component presents an interest and qualities which conservation and protection are the subject of few concerns.

The **socio-economic value** of a given component is considered to be:

- **high**, when the component is the subject of legal or regulatory protection measures (threatened or vulnerable species, conservation park, etc.) or is essential for human activities (land);
- **moderate**, when the component is valued (economically or otherwise) or used by a significant portion of the population concerned without however being subject to legal protection;
- **low**, when the component is little or not valued or used by the population.

The value of the component integrates both the ecosystem value and the socio-economic value, using the higher of these two values, as shown in the following table.

Table 55 : Matrix for the determination of the environmental component value

Socio-economic value	**Ecosystem value**		
	High	**Moderate**	**Low**
High	High	High	High
Moderate	High	Moderate	Moderate
Low	High	Moderate	Low

For physical and biological environments, the environmental value is based on the establishment and integration of two (02) elements (ecosystem element and social element).

In the case of the human environment, only the social value is taken into account to determine the environmental value.

This social value expresses the relative importance attributed by the public, the various technical services of the State, the local administration or any other legislative or regulatory authority to a given environmental component.

It indicates the popular or political desire or will to maintain the integrity or original character of a component. This will be expressed by the legal protection granted to it or by the public interest in it at local or regional level.

Social value is established according to the concerns of the population concerned by the community component. The perceptions and concerns gathered from populations, such as public consultations, are used to establish this value.

The intensity of the environmental impact varies from very high to low and results from the combination of the factor assigned to the degree of disturbance and that assigned to the value of the component. The following table shows the different possible combinations.

Table 56 : Matrix to determine the impact's intensity

Disturbance degree	Component value		
	High	Moderate	Low
High	Very high	High	Moderate
Moderate	High	Moderate	Low
Low	Moderate	Low	Low

VIII.1.3.2. DURATION

The duration of the impact determines the period during which the effects will be felt in the environment. It is not necessarily equal to the space of time during which the immediate effects of the impact are felt since residual effects secondary to the initial cause can arise long after the latter is dissipated.
When an effect is intermittent, its frequency is determined in addition to the duration of each occurrence.

The duration of the impact can be:

- **long**, when the effects are felt permanently continuously or discontinuously for the life of the equipment or activities and even beyond in the case of irreversible impacts;
- **moderate,** when the effects are temporarily felt continuously or discontinuously over a relatively prolonged period of time but less than the life of the equipment or activities;
- **short**, when the effects are felt temporarily in a limited space of time, generally corresponding to the construction period or the start of activities.

VIII.1.3.3. EXTENT

The extent of the impact refers to the area affected by the effects and the proportion of the population affected. It may be:

- **regional** when the impact affects a large area, or several components located at a distance from the project, or when it is felt by the entire population of the study area, or by a significant proportion of the population of the receiving region;
- **local** when the impact affects a relatively small space or a certain number of components located inside, near or at a certain distance from the project site, or when it is felt by a limited proportion of the population of the study zone;
- **punctual** when the impact only affects a very limited space or a component located inside or near the project site, or when it is felt only by a small number of individuals in the area of study.

VIII.1.3.4. IMPORTANCE

The combination of the intensity, extent and duration of the impact through the evaluation grid below makes it possible to determine its importance on a component of a given environment. The importance of the impact is judged on five (05) levels according to the value of the variables that define it.
The significance of each environmental impact is assessed taking into account the mitigation or improvement measures integrated into the project.
After this initial assessment, if it turns out that these analyzed impacts are not minor and that the suggested measures are not effective, specific mitigation measures can be suggested to allow optimal integration of the project into its environment.
Mitigation measures aim to avoid, mitigate or compensate the negative social and environmental impacts of a project by prioritizing solutions with zero negative impact.
With regard to positive impacts, improvement or optimization measures are suggested with the aim of perpetuating these assets, making them better and allowing a greater layer of the given components to benefit from.

The suggested mitigation and optimization measures include operationality, adaptability to the context, ease of implementation and above all, value for money in order to benefit all parties.

Table 57 : Matrix for the determination of the importance of the environmental impact

Intensity	Extent	Duration	Importance
Very high	Regional	Long	Very high
		Moderate	Very high
		Short	Very high
	Local	Long	Very high
		Moderate	Very high
		Short	High
	Punctual	Long	Very high
		Moderate	High
		Short	High
High	Regional	Long	Very high
		Moderate	High
		Short	High
	Local	Long	High
		Moderate	High
		Short	Moderate
	Punctual	Long	High
		Moderate	Moderate
		Short	Moderate
Moderate	Regional	Long	High
		Moderate	Moderate
		Short	Moderate
	Local	Long	Moderate
		Moderate	Moderate
		Short	Low
	Punctual	Long	Moderate
		Moderate	Low
		Short	Low
Low	Regional	Long	Moderate
		Moderate	Low
		Short	Low
	Local	Long	Low
		Moderate	Low
		Short	Very Low
	Punctual	Long	Low
		Moderate	Very Low
		Short	Very Low

Following the implementation of specific mitigation measures, the residual impact will be determined and follow-up and evaluation measures will be recommended to supervise and better manage them through a monitoring plan.

The following figure is a summary of the steps to follow in determining the significance of the impact.

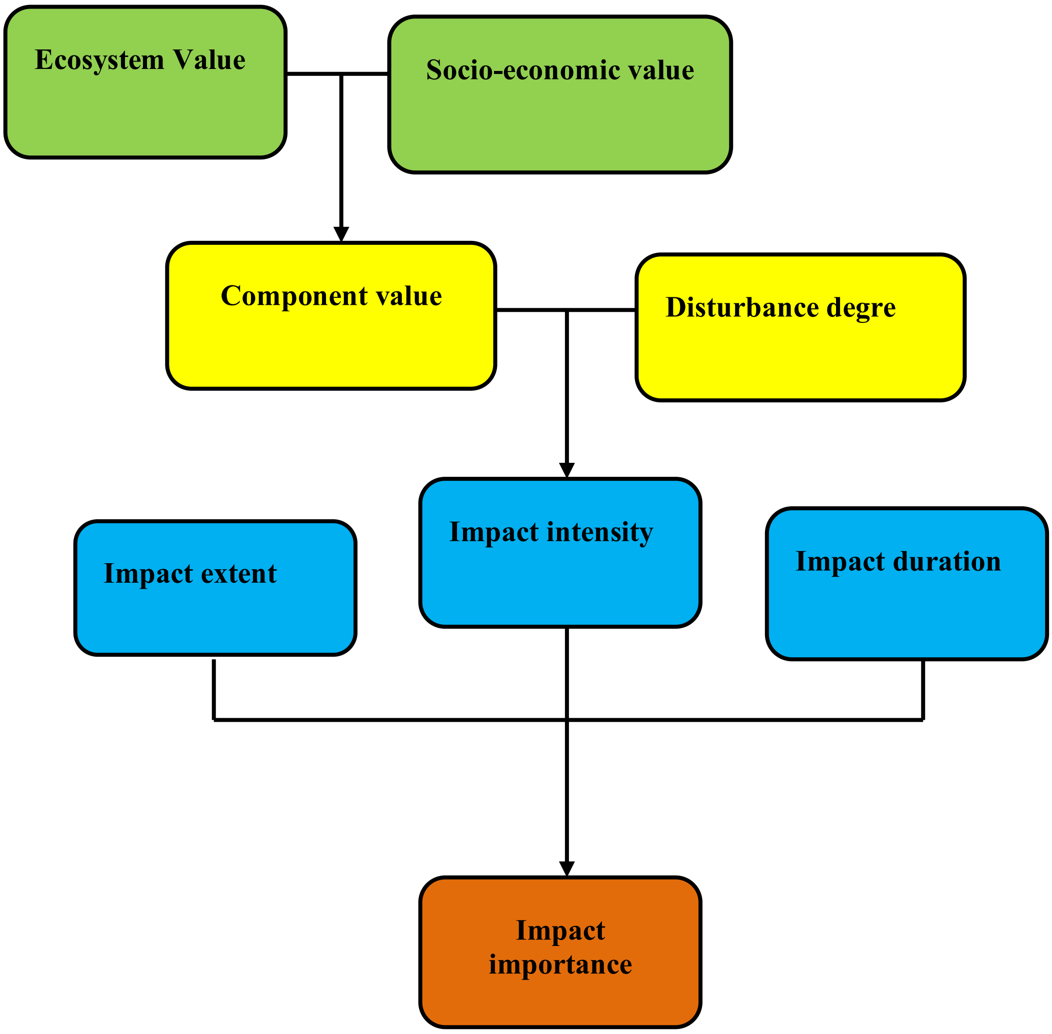

Figure 20 : Process for identifying the significance of the impact

VIII.2. ENVIRONMENTAL AND SOCIAL CHALLENGES (VALUE OF THE ENVIRONMENTAL COMPONENT -VCE)

This part tackles the environmental components likely to be impacted by the project in these construction and operational phases.

VIII.2.1. AIR QUALITY

The construction and operation of Malicounda thermal power plant will generate air pollutants and greenhouse gases. These emissions are likely to affect air quality.

The value of the **environmental component remains high** because no deterioration of air quality was noted in the project area.

VIII.2.2. SOIL, SURFACE WATER AND GROUNDWATER QUALITY

Site preparation and construction of Malicounda thermal power plant are likely to affect soil quality and, in turn, groundwater.

It is noteworthy that the project site **is located on tropical ferruginous soils that are not or only slightly leached or “Dior” soils.** These soils, thanks to their sandy materials, are well drained, but their humus horizon is very exposed to wind and water erosion.

They are generally used for rain-fed agriculture and grazing. Thus, the value of the component is **considered to be high.**

VIII.2.3. QUALITY AND AVAILABILITY OF WATER CONSUMPTION

The water requirements during the construction and operation phases of Malicounda thermal power plant have not yet been estimated. However, water will be supplied by drilling which will be carried out on the site with a flow rate of 6 m^3/h.

The surrounding villages of the project site are supplied with drinking water by boreholes managed by ASUFOR. The drilling exploited in the project village (Malicounda Wolof) fails to meet the water needs of the population.

Given the previously discussed elements and the importance of the resource for local populations, the **component value is high.**

VIII.2.4. VEGETATION OF THE DIRECT INFLUENCE AREA

The site preparation and development work will inevitably lead to deforestation and land clearing activities over an area of 6 ha.

Indeed, the site is characterized by fields of rain-fed crops. These fields are dotted with trees and shrubs. Among these species, two (02) partially protected plant species (Andansonia digitata (Baobab) and Faidherbia albida (Kaad)) have been identified inside the site.

The environmental value is considered to be **average** with regard to the interest represented by the importance of preserving flora.

VIII.2.5. FAUNA ET AVIFAUNA

The wildlife habitats in the project area are greatly modified by agricultural activities. The site to house the thermal power plant is located on agricultural land intended for rain-fed agriculture. The wildlife and bird life potential is low in the project area, mainly due to the pressure exerted by humans on wildlife habitats. The need to preserve the fauna in this environment justifies the **average** environmental value.

VIII.2.6. NOISE LEVEL

Studies carried out on the site's initial sound environment have revealed that the sound environment of the semi-urban environment to host the project is very quiet with an average residual noise level of 44.6 dB.

The environment in the initial state is of the unpolluted (sound) type. Construction work, as well as activities related to the operation of the plant, will generate noise. This generated noise could cause noise pollution for local populations but also for workers. Thus, the value of the component is considered high.

VIII.2.7. HEALTH AND SAFETY OF POPULATIONS

The installation and operation of Malicounda thermal power plant presents health and safety risks for workers and local residents. Thus, the health and safety of workers as well as that of the surrounding populations must be taken into consideration to alleviate any inconvenience. Therefore, the value of the component (health and safety of populations and workers) is considered to be **high** because the preservation of the health and safety of the population is principal.

VIII.2.8. ECONOMIC ACTIVITIES

The main economic activities in the project area are: agriculture, fishing, animal husbandry and industry. The completion of this project will have a major impact on economic activities through the recruitment of labor, the development of small businesses, the purchase of goods and services, etc.

The project will also result in the loss of agricultural activities over an area of 18 ha. In view of these results, the value of the component (economic activity) is **high**.

VIII.2.9. LANDSCAPE

The location of the plant will change the visual perception in the area. Indeed, the presence of chimneys could cause visual discomfort. The value of the environmental component is **high.**

VIII.2.10. SUMMARY OF ENVIRONMENTAL AND SOCIAL CHALLENGES

The table below provides a summary of the environmental and social issues in the project area.

Table 58 : Summary of environmental and social challenges of the project area

Challenges	**Component values Environmental (VCE)**
Quality of air	High
Soil, surface and groundwater quality	High
Quality and availability of drinking water	High
Vegetation	Moderate
Fauna and avifauna	Moderate
Economic activities	High
Hygiene, health, security	High
Sound climate	High
Scenery	High

VIII.3. IDENTIFICATION OF THE MAJOR PROJECT IMPACTS

In this section, all the impacts relating to the project during the construction phase as well as during the operation of the power plant are detailed. Impact management measures are suggested for each component of each environment (physical, human, biological) impacted by the project.

VIII.3.1. ON THE PHYSICAL ENVIRONMENT

VIII.3.1.1. DURING THE CONSTRUCTION PHASE

The activities that are likely to have an impact on the physical environment of the project area are works to liberate the site (deforestation, clearing, etc.), civil engineering works (earthworks, leveling, backfilling, etc.), setting up in place of equipment, construction work, generation of waste, etc. These activities are likely to lead to:

- dust emissions from the transport and storage of construction materials;
- exhaustive gas emissions from the operation of vehicles and construction sites;
- risks of soil contamination, subsoil and water resources by discharges, accidental oil spills or the use of dangerous chemicals but also by poor waste management;
- soil degradation following civil works and the installation of the site;

- the modification of the surface and groundwater flow regime due to civil engineering works (leveling, earthworks, backfilling, etc.).

VIII.3.1.1.1. Impacts on the atmospheric environment

On the air quality

Air quality will be affected by pollutant and especially dust emissions from demolition and reconstruction activities, including the use of construction materials, vehicles and construction equipment.

During the rehabilitation works, the dust could be propagated during the movement of vehicles, the transport of materials and to a lesser extent, during the operations of loading, unloading and /or storage of construction materials.

Indeed, if the loads of materials (sand, gravel, etc.) are not covered with tarpaulins, the trucks risk losing throughout their operations a part of the materials thus constituting inconvenience for the populations of the localities crossed but also for workers on site. In addition, the plant site is located near the village of Keur Maissa Faye where the first dwellings are located at approximately 40 m from the site.

In Malicounda, the main dust emissions occur during the dry season between October and June. These would be greatly accentuated if the works take place during this period.

As for the exhaust gas emissions, they will come from the operation and use of machines, vehicles, generator sets, concrete plants, etc. All of this equipment burns diesel oil and emits CO, CO_2, SOx, NOx, etc.

However, these quantities of released pollutants should be relatively small and over a short period. Thus, the significance of the impact of construction work on air quality is considered to be low.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Punctual	Short	Low

<u>**Reduction measures**</u>

In order to make the impacts on air quality insignificant during the construction phase, the study recommends the following mitigation measures:

- water the worksite floor and traffic lanes to minimize the generation of dust (at the rate of 2 tankers with a capacity of 30 m^3 per week for the first 10 months);
- restrict the speed of trucks to 30 km /h at the level of housing and on site;
- cover the transport trucks with site materials (rubble, sand, etc.) with tarpaulins;
- monitor air quality by installing diffusion tubes
- ensure rigorous planning of work periods according to the seasons (if possible);
- stop unused vehicles and engines while avoiding the standby position such as an engine slow motion;
- ensure preventive and curative maintenance of gas emitting equipment exhaust;
- define the desired technical specifications for construction machinery with regard to standards national and international in terms of exhaust gas;
- inform and raise awareness among local residents.

- **On the climate**

During the construction of the plant, the operation of site machines, equipment and vehicles, as well as the use of trucks to transport construction materials will cause greenhouse gas (GHG) emissions such as carbon dioxide (CO_2). Added to this is the preparation of the land which will require deforestation located inside the plant site. However, it has been established that vegetation is a "carbon sink" absorbing very large amounts of atmospheric carbon, which contributes to lowering the amount of atmospheric CO_2.

However, these emissions (intermittent and limited) from the operation of vehicles, machinery and site equipment, as well as the deforestation of the site of the power island (6 ha) will not have any significant impact on the climate change. Thus, the significance of the climate impact of construction works is considered to be low.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Local	Short	Low

Reduction measures

Even if the development works for the release of the right of way cannot have a significant impact on the climate, the study recommends the following measures:

- minimize as much as possible the impacts on the climate;
- define the technical specifications desired for construction machinery with regard to international standards in terms of exhaust gases;
- stop unused vehicles and engines while avoiding the standby position such as an engine slow motion;
- carry out regular and complete maintenance and technical inspection of site vehicles and machinery to minimize pollution from poor combustion;
- comply with national and international standards in terms of GHG emissions.

The application of these measures will make it possible to follow the requirements of AfDB Operational Safeguard 4 on the rational use of resources and pollution prevention. The objectives of this OS are, among other things, to avoid or reduce negative impacts on the environment by avoiding or reducing the pollution generated by project activities and especially the GHG emissions related to projects.

VIII.3.1.1.2. Impacts on soil and water resources

The construction of the thermal power plant is likely to affect the quality of the soil and, in turn, surface and groundwater. These potential impacts are presented in the subsections below.

- **Modification of local topography and soil destructuration**

During the construction phase, earthworks, leveling and excavations which will be carried out on the site will modify the soil profile and the local topography. This modification will slightly disturb the natural runoff of rainwater because the drop is low. Thus, the altitudes of the site of the power plant vary between 10 and 15 m.

These construction works could also invert the natural horizons of the soil by carrying out embankments and cuttings which can lead to a depletion of the soil and a disturbance of the pedogenetic process. However, this work will be limited to the site (18 ha), more particularly on the 06 ha necessary for the establishment of the power plant and will be carried out over a short period. Thus, the importance of the impact of the preparation activities is considered to be low on the modification of the local topography and on the soil destruction.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Local	Short	Low

Soil waterproofing and compaction

During construction work, compaction and / or paving of the soil can lead to waterproofing and deep compaction of the soil. These compacted and waterproofed soils will no longer be able to properly fulfill their environmental functions.

The development of access tracks, the use and parking of heavy machinery, embankment activities and the laying of foundations could cause the soil to settle, if the latter does not have sufficient support to bear the weight of these devices.

Consequently, the work could modify the speed and infiltration rate of runoff water as well as the recharge rate of the aquifers. This is how the stagnation and/or runoff of water is accentuated, thus causing floods and/or water erosion of the soil.

However, the site where the power plant is located is made up of non-ferrous or lightly leached tropical ferruginous soils or "Dior" soils which are loose soils and highly waterproof, and the construction works concern only a limited area (06 ha surroundings) and will extend over a short period. Thus, the importance of the impact is considered low.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Local	Short	Low

Pollution of soil, surface and groundwater

- **by accidental spillage or leakage of chemicals**

Site preparation works, as well as the construction of the power plant, represent a risk of soil contamination, surface and groundwater.

Indeed, the storage and handling of products, certain substances (fuels, lubricating oils, used oils, chemicals, etc.) used for the operation and maintenance of equipment, machines and construction vehicles can be the source of spills, accidental or leakage likely to infiltrate the soil, runoff water and by ricochet, groundwater.

However, these accidental spills and leaks are punctual even if the immediate environment of the site may be inadvertently affected.

It is noteworthy that on the site and its surroundings, there are no watercourses, nor perennial or temporary pools. In addition, the water table is captured at about 30 meters. In addition, the works will only concern the area required for the power plant (06 ha) and will be carried out over a short period.

Thus, the significance of the impact is considered to be low.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Local	Short	Low

- **By waste generation**

These previously cited works will be sources of solid and /or liquid waste generation (liquid effluents, packaging, cable reels, empty containers, worn spare parts for vehicles, etc.).

Poor management of this waste at the site level could lead to the dissolution of liquid waste and the leaching of solid waste which could contaminate soil, surface water and groundwater by infiltration.

However, construction waste is generally inert waste (cuttings, rubble, plaster, cables, coils, etc.) which is generated over a short period of time.
Thus, the significance of the impact is considered to be low.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Local	Short	Low

Reduction measures

The project company must comply with AfDB Operational Safeguard 4 which requires the reduction of hazardous and non-hazardous waste at source and its treatment and disposal in an environmentally sound manner. The measures recommended below must also be applied in order to make the impact very weak on soil and surface and groundwater:

- study the soil;
- define the routes of heavy vehicles (work tracks) and work areas so as to limit the rolling surfaces and soil compaction;
- limit the site's footprint to the strictly necessary surface;
- rehabilitate the premises after works;
- provide a water drainage system before the rainy season to ensure the flow of runoff to natural circuits;
- provide watertight pits for collecting sewage;
- ensure that no vehicle maintenance is carried out on site;
- take into consideration standard NS 05-061 on wastewater before any discharge of effluents into the natural environment;
- limit accidental spills and leakages by:
    - the provision of anti-pollution kits;
    - the storage of oils and other dangerous products in watertight retention basins;
- ensure that vehicles and construction equipment have a technical inspection in order
- collect solid and liquid waste according to a waste management plan in accordance with national and international regulatory provisions;
- avoid or, failing this, limit and control the intensity or the mass flow rate of the discharges;
- take into account existing environmental conditions;
- avoid generating hazardous and non-hazardous waste;
- reduce the production of waste;
- recover and reuse waste in a way that is safe for human health and the environment;
- treat, destroy and eliminate waste which cannot be recycled or reused;
- ensure that there are landfills that meet acceptable standards and, if there are, use them;
- set up its own recycling and disposal facilities on the project site;
- educate and train staff on solid and liquid waste management;
- implement an HSE policy.

With the application of these recommendations, the importance of these aforementioned impacts on the soil, the surface and groundwater resources will be **very low**.

VIII.3.1.1.3. Impact on water resources used by populations

The preparation and construction of the plant will require in short-term water requirements (for civil engineering, soil watering, cleaning operations, workers' needs, etc.).

According to the WHO, to drink and meet their hygiene needs, each person needs 0.02 to 0.05 m^3 / d. The recruitment of 400 employees is planned for the construction works. Thus, the amount of water necessary to meet sanitary needs is estimated between 08 and 20 m^3 / d. As for the other needs, they have not been estimated yet.

Water will be supplied by drilling (6 m^3/h) which will be carried out on site. During construction works, water will be used in a rational way so as not to compete with the water supply of the populations.

Given the low pumping rate and the productivity of the aquifer that will be exploited (aquifer from the Maestricht clayey sands), as well as the short duration of the construction work, the significance of the impact is considered to be low.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Local	Short	Low

<u>Reduction measures</u>

The study recommends the following measures:

- collect and use rainwater for watering the tracks if the work is carried out made during the rainy season;
- set up a drainage network in order to ensure the runoff of rainwater towards the natural drainage circuits;
- carry out a hydrogeological and geophysical study to determine the exploitable aquifers, the optimal pumping rates, the dimensions of the equipment (water tower, etc.) and the suitable location for drilling;
- approach the DGPRE and the Regional Division of Hydraulics to obtain the required authorizations for drilling installation;
- reuse, if necessary, water tanks in good condition to avoid water leaks;
- educate employees on the importance of water and the need to conserve and avoid waste.

The application of the above measures will make it possible to mitigate the potential impacts on the water resources used by the populations. In addition, they are in line with the requirements of the AfDB Operational Safeguard 4 on the rational use of resources and pollution prevention, one of the major objectives of which is to promote the sustainable use of resources, in particular energy and water.

VIII.3.1.2. DURING THE OPERATION PHASE

VIII.3.1.2.1. Impacts on the ambient conditions

On the quality of air

In the operational phase, the deterioration of air quality and air pollution will be mainly due to emissions from the combustion of fuel oil by power plant groups.

Indeed, the operation of the plant will lead to emissions of pollutants and dust (such as SOx, NOx, PM10, PM2.5 and CO) and to a lesser extent, Volatile Organic Components (VOCs) and Polycyclic Aromatic Hydrocarbons (PAH). The concentrations of SOx, NOx, PM_{10}, $PM_{2.5}$ and CO must respect both the Senegalese benchmark and the BM limits.

Carbon dioxide (CO_2) likely to be found in the exhaust gases during the combustion of fuel oil in the seven (07) diesel groups of the power plant also contributes to the deterioration of air quality and warming climatic. The results of the characterization of the initial environment in the ambient air quality component presented in Chapter 5 showed that the site is free from any pollution. The air quality in the project area is considered to be good.

To carry out an atmospheric dispersion study to estimate the impact on quality from the local air of the project, the EES cabinet requested the expertise of NUMTECH.
The dispersion of project releases into NO_2, SO_2, CO, and PM_{10} and $PM_{2.5}$ dust is studied thanks to the implementation of the ADMS atmospheric dispersion software. The concentrations thus simulated in the project environment are then compared to Senegalese and international air quality standards, in order to conclude as to the impact of this project.
The WHO guidelines were "developed to support actions to achieve air quality that protects public health in different contexts". In addition to the guideline values, and given the difficulty in reaching certain guidelines, the WHO suggests a step-by-step approach by setting intermediate targets to gradually reduce air pollution.
In the case of SO2, the daily guideline set at 20 µg / m^3 is particularly difficult to reach. The first intermediate target of 125 µg / m^3 has been adopted by Senegalese national regulations and can be considered as a reasonable and feasible target in a certain number of developing countries. We will therefore endeavor in this study to compare the results of the 24-hour averages with the first intermediate target of 125 µg / m^3.
Malicounda power plant project has 2 chimneys, marked S1 and S2. The chimney S1 groups together 4 barrels, and S2 groups together 3 barrels.
The characteristics of S1 and S2 are presented below.

Paramètres	Unité	S1	S2
Hauteur par rapport au sol	m	35*	35*
Diamètre	m	3.2	2.77
Température des rejets	°C	183	183
Vitesse d'émission	m/s	20.5	20.5
Taux d'émission en SO_2	g/s	167	125
Taux d'émission en NOx	g/s	264	198
Taux d'émission en CO	g/s	16.4	12.3
Taux d'émission en PMtotales	g/s	18.6	13.9
Taux d'émission en PM_{10}	g/s	14.88	11.12
Taux d'émission en $PM_{2.5}$	g/s	14.32	10.703

** hauteur initialement envisagée. Cette hauteur a en réalité fait l'objet de tests, comme décrit ci-dessous.*

Legend: parameters/unit/ S1/S2/height from the ground/ diameter/temperature of discharges/transmission rate/SO2 transmission rate/Nox transmission rate/ CO transmission rate/ total PM transmission rate/ PM10 transmission rate/PM 2.5 transmission rate.

The initial targeted height for the chimneys is 35m. However, initial dispersion calculations showed that the impact of the project on its environment was not minor for this height and could lead to overshoots of Senegalese regulatory thresholds. Additional calculations have therefore been made and are presented below to determine the height of the chimney to limit the impact of fallout.

The following calculations were made:

	NO_2	SO_2	PM_{10}	$PM_{2,5}$	CO
Concentration moyenne annuelle	x	x	x	x	
Maximum journalier (sur 24h)		x	x	x	x
Maximum sur 8 heures glissantes					x
Maximum horaire	x				x
Maximum sur 30 minutes					x
Maximum sur 15 minutes					x
Maximum sur 10 minutes		x			

Legend: annual average concentration/ daily maximum (over 24h)/ maximum over 8 sliding hours/ hourly maximum/ maximum over 30 minutes/ maximum over 15 minutes/ maximum over 10 minutes.

- **Dispersion results for SO_2:**

The initial targeted height for the chimneys (35 m) leading to thresholds being exceeded, several additional heights were considered. Following this series of tests, a decision of moving towards a chimney height of 42 m was made, making it possible to limit the observed overshoots. The corresponding results are presented below. The regulatory thresholds are presented at the bottom of the table. The exceedance of these thresholds is highlighted in bold.

Concentration en SO_2 (µg/m³)	Moyenne annuelle		Moyenne sur 10 min		Moyenne journalière	
Hauteur de cheminée	35m	42m	35m	42m	35m	42m
Max. sur le domaine	**21**	16	**655**	496	**294**	**226**
1	1	< 1	58	35	9	2
2	8	6	472	340	196	135
3	9	7	436	355	**208**	**165**
4	6	5	379	338	**130**	107
5	3	2	258	239	74	68
6	2	2	389	332	67	55
7	1	1	322	291	80	72
8	5	5	239	219	104	97
9	3	3	171	164	75	70
10	8	7	294	274	122	108
Seuil correspondant	20 µg/m³ (OMS) 50 µg/m³ (Sénégal)		500 µg/m³ (OMS)		125 µg/m³ (OMS – 1ère cible intermédiaire et Sénégal)	

Legend: SO2 concentration (µg / m3)/ yearly average/average over 10 minutes/daily average/ chimney height/ maximum on the field/ corresponding threshold/ 20 µg / m3 (OMS) 50 µg / m3 (Senegal)/ 500 µg / m3(OMS)/ 125 µg / m3(OMS- first intermediate target and Senegal)

The most affected receiving points are point n ° 2 and point n ° 3. These are indeed the points closest to the sources, after point n ° 1. Point n ° 1 is only very slightly impacted because of the height of the chimneys. Indeed, the plumes emitted at height must travel a certain distance before being sufficiently open to impact the ground.

Point n ° 4 is then the most impacted one. This is the next point closest to the sources. Points n ° 6 and

7, however located at similar distances from the sources, are clearly less impacted because they are located north of the sources, impacted very little by the winds which blow mainly towards the site.

In annual average concentrations, the atmospheric fallout of the project is mainly towards the south, in accordance with the direction of the prevailing winds (coming from the north). The east and west directions are affected to a lesser extent. The north of the site has very little impact on an annual average.

In daily concentrations, the main fallout is more isotropic, towards the northeast, east, south, and southwest. The north and northwest directions are also little affected.

In more acute concentrations (hourly or shorter), logically all directions are affected.
These guidelines are found on the maps of all pollutants.

The results obtained show that in annual average SO2 concentration, the guideline of 20 µg / m^3 set by the WHO is slightly exceeded on the study area (about 700 meters south of the chimneys) for a height of the chimneys 35m. It is respected at the level of the receiving points considered. For a chimney height of 42 m, the guideline is respected.
In maximum concentration over 10 minutes, the WHO guideline of 500 µg / m^3 is also exceeded for 35 m chimneys, on the study area (about 500 meters south of the chimneys), but is respected at receiving points. For a 42 m chimney, this threshold is respected throughout the study area.

Finally, in maximum daily concentration, the first WHO intermediate target, and the Senegalese limit value of 125 µg / m^3 are exceeded for chimneys of 35 m, on the study area, as well as at receptor no. 3 and 4. These exceedances concern a fairly wide area towards the northeast, east, south and southwest sectors, which begins around the project site limits, and extends to a maximum distance of 2 km from the chimneys.

With a 42 m high chimney, going beyond point n ° 4 is eliminated.

	Seuil	35m		42m	
		Concentration simulée	Nombre de dépassements moyens annuels	Concentration simulée	Nombre de dépassements moyens annuels
SO2 moyenne sur 10min au point max sur le domaine	500 µg/m^3	**655**	13 heures	496	0
SO2 moyenne sur 24h point max sur le domaine	125 µg/m^3	**294**	14 jours	**226**	6 jours
SO2 moyenne sur 24h au point n°3	125 µg/m^3	**208**	1 jour	**165**	1 jour
SO2 moyenne sur 24h au point n°4	125 µg/m^3	**130**	1 jour	107	0

Legend: threshold/ 35 m simulated concentration/number of average annual exceedances/simulated concentration/ number of average annual exceedances/ SO2 average over 10 minutes at the maximal point on the field/ SO2 average over 24 hours at the maximal point on the field/ SO2 average over 24 hours on the point no.3/ SO2 average over 24 hours on the point no.4/ 13 hours/ 14 days/ 1 day/ 1day/ 6 days/ 1 day

According to the results of the model, the height of 42 m allows a clear drop in the exceedances of the daily threshold. For point n ° 3, located east of the discharge, only one day of exceedance is simulated.

- **Dispersion results for NO_2:**

For a 35 m chimney, the threshold relating to the annual average concentration is approached, and that relating to the maximum hourly concentration is just exceeded, in a restricted area of the study area only. Given the overwhelming nature of the results presented here, these two thresholds could therefore be correctly respected if we consider the contribution of the project. On the other hand, with a height of 42 m for the chimneys, the thresholds are respected throughout the area.

Concentration en NO_2 (µg/m³)	Moyenne annuelle		Moyenne horaire	
Hauteur de cheminée	35m	42m	42m	42m
Max. sur le domaine	39	36	**203**	191
1	22	21	80	60
2	26	25	184	171
3	28	27	181	175
4	25	25	178	174
5	23	23	162	158
6	22	22	181	176
7	21	21	180	177
8	26	25	172	171
9	24	24	164	160
10	31	29	177	175
Seuil correspondant	40 µg/m³ (OMS et Sénégal)		200 µg/m³ (OMS et Sénégal)	

Legend: NO2 concentration (µg / m3)/ yearly average/hourly average/ chimney height/ maximum on the field/ corresponding threshold/ 40 µg / m3(OMS and Senegal)/ 200 µg / m3(OMS and Senegal)

- Dispersion results for CO:

The WHO guidelines are widely respected by the contribution of the project across the entire study area, this being for the two considered heights.

Concentration en CO ($\mu g/m^3$)	Moyenne sur 15 min		Moyenne sur 30 min		Moyenne horaire		Moyenne sur 8h glissantes		Moyenne journalière	
Hauteur de cheminée	35m	42m	35m	42m	35m	42m	35m	42m	35m	42m
Max. sur le domaine	64	48	62	47	59	44	44	35	29	22
1	6	3	5	3	5	3	2	1	1	<1
2	46	33	45	33	42	31	30	24	19	13
3	42	34	41	33	38	31	29	24	20	16
4	37	33	36	32	34	30	28	25	13	11
5	25	23	24	22	21	20	16	15	7	7
6	38	32	37	31	34	30	18	16	7	5
7	31	28	30	28	29	26	22	20	8	7
8	23	21	21	20	19	17	15	15	10	10
9	16	15	14	14	12	11	10	9	7	7
10	28	26	27	25	25	23	19	18	12	11
Seuil correspondant	100 mg/m^3 (OMS)		60 mg/m^3 (OMS)		30 mg/m^3 (OMS)		10 mg/m^3 (OMS)		30 mg/m^3 (Sénégal)	

Legend: CO concentration (µg / m3)/ average over 15 minutes/ average over 30 minutes/hourly average/ average over 8 sliding hours/daily average/chimney height/ maximum on the field/corresponding threshold

- **Dispersion results for dust:**

The different thresholds are all respected by the contribution of releases uniquely from the plant.

Concentration en PM_{10} ($\mu g/m^3$)	Moyenne annuelle		Moyenne journalière	
Hauteur de cheminée	35m	42m	35m	42m
Max. sur le domaine	1.5	1.1	20	15
1	0.1	<0.1	1	<1
2	0.6	0.4	14	10
3	0.7	0.5	14	11
4	0.5	0.4	9	8
5	0.2	0.2	6	5
6	0.2	0.1	5	4
7	0.1	0.1	6	5
8	0.4	0.3	6	6
9	0.2	0.2	4	4
10	0.6	0.5	8	7
Seuil correspondant	20 $\mu g/m^3$ (OMS) 80 $\mu g/m^3$ (Sénégal)		50 $\mu g/m^3$ (OMS) 260 $\mu g/m^3$ (Sénégal)	

Legend: PM10 concentration (µg / m3)/ yearly average/daily average/ chimney height/ maximum on the field/ corresponding threshold

As with PM_{10}, the different thresholds are all respected uniquely by the contribution of the plant discharges.

It is important to note that the simulated $PM_{2.5}$ concentrations are slightly higher than those simulated in PM_{10}, while the emission in $PM_{2.5}$ is slightly lower (according to the hypotheses considered, PM_{10} represents 90% of the total PM, whereas $PM_{2.5}$ represents 77%). This is due to the fact that the larger PM_{10} particles settle more efficiently than the $PM_{2.5}$. Consequently, the loss of particles in the plume is greater for PM_{10}, which leads to lower concentrations than for $PM_{2.5}$.

Concentration en PM_{10} ($\mu g/m^3$)	Moyenne annuelle		Moyenne journalière	
Hauteur de cheminée	35m	42m	35m	42m
Max. sur le domaine	1.7	1.3	24	18
1	0.1	<0.1	1	<1
2	0.6	0.5	16	11
3	0.7	0.6	17	13
4	0.5	0.4	11	9
5	0.2	0.2	6	6
6	0.2	0.2	6	5
7	0.1	0.1	7	6
8	0.4	0.4	8	8
9	0.3	0.2	6	5
10	0.7	0.6	10	9
Seuil correspondant	10 $\mu g/m^3$ (OMS) -		25 $\mu g/m^3$ (OMS) -	

Legend: PM10 concentration (µg / m3)/ yearly average/daily average/ chimney height/ maximum on the field/ corresponding threshold

Conclusion

The main objective of this simulation was to define the impact of the diesel thermal power plant project in Malicounda, Senegal, on the air quality of its direct environment.

The study was carried out using the ADMS 5 atmospheric dispersion model, taking into account the local meteorology, the environmental context, the building on site, as well as the characteristics of the sources of emissions. A major operating scenario was considered (constant emission 24 hours a day, 7 days a week). The pollutants NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$ have been studied. The first dispersion calculations were carried out for the height envisaged for the 35 m chimneys. However, they have showed several exceedances of the air quality thresholds for SO_2. Consequently, a specific calculation was carried out to determine the height of the chimney making it possible to limit the frequency of exceeding these thresholds and a height of 42 m was thus determined.

In summary, it can be retained that, for the emission data and operating scenario hypotheses considered:

- For a chimney height of 35 m, several air quality thresholds are exceeded in SO_2:
  - the guideline of 20 µg / m^3 to be observed on an annual average is very slightly exceeded in the field of study;
  - the guideline of 500 µg / m^3 to be observed on average over 10 minutes is clearly outdated in the area of study;
  - the 2nd WHO intermediate target of 125 µg / m^3 (which is also a value limit in Senegalese regulations) is exceeded over a wide area, including several receiving points.
  - For other pollutants, the different air quality thresholds are respected.
- For a chimney height of 42 m, only the 2nd WHO intermediate target of 125 µg / m^3 (which is also a limit value in the Senegalese regulations) is exceeded in a restricted area. The maximum estimated frequency of exceeding this threshold is six (06) days per year maximum on the domain and one (01) day per year at point n ° 3.

On the climate

The operation of the plant will result in greenhouse gas (GHG) emissions. These GHGs are gaseous components that absorb infrared radiation emitted from the earth's surface. They thus contribute to the greenhouse effect. One of the complex factors of global warming is the increase in their concentration in the Earth's atmosphere.
The combustion of heavy fuel oil used for diesel engines releases pollutants from the chimneys. These pollutants are characterized by sulfur oxides (SO_2), nitrogen oxides (NO and NO_2), carbon monoxide (CO) and particulate matter (PM_{10}). Also, GHGs like CO_2 and N_2O will be emitted in the gaseous effluents.
CO_2 is the primary reaction product of the combustion of all fossil fuels and is directly linked to its carbon content. The carbon content of the fuel oil to be used by the power plant is 59.57%.

N_2O, CH_4, like CO_2 directly contribute to climate change caused by greenhouse gases and by the absorption of infrared rays reflected from the earth and coming from the sun. In the troposphere, nitrogen peroxide breaks down in the presence of O_3 (Ozone) and forms NO_2 and NO, the mixture of which forms nitrogen oxides (NOx).

The evaluation of GHG emissions is carried out using CO_2 emission factors which are determined from the physical composition of the fuel consumed and its calorific value or from emission factors.

The seven (07) groups of the plant will burn approximately 197,000 (540t x 365d) tons of fuel oil /year. The calculated CO_2 emissions are around 108,000 tons of CO_2 per year. Thus, measures to reduce this gas must be taken to contribute to the fight against anthropogenic climate change. Considering all these factors, the significance of the impact can be considered strong on air quality and climate change.

VCE	Disturbance	Intensity	Extend	Duration	Importance
High	Moderate	High	Local	Long	High

Reduction measures

The study recommends the following mitigation measures to reduce the significance of the impact from high to moderate:

- identify sources of emissions and set up an air quality management system;
- assess the air quality in the project area of influence;
- ensure long-term monitoring of ambient air quality at the various sites listed as potential receptors;
- carry out regular and complete maintenance and technical inspection of the vehicles transporting the fuel to minimize pollution from poor combustion;
- monitoring atmospheric emissions of Nox, SO_2 and PM at the level of chimneys;
- have particulate and molecular filters in the chimneys;
- ensure the use of an oil with a low sulfur content (less than 2% in accordance with the agreement between SENELEC and Malicounda Power);
- carry out the desulfurization of the combustion gases;
- use burners with low Nox emissions;
- create green spaces for the protection of the environment and the quality of life of populations, but also to promote the absorption of CO2, the main greenhouse gas, by photosynthesis;
- carry out reforestation campaigns;
- check the possibilities of financing carbon offset projects (reforestation campaign in the area, projects integrating the implementation of renewable energies, CDM projects);
- switch to gas as soon as possible to significantly minimize GHG emissions.

As the construction phase, the application of these measures will make it possible to comply with the AfDB Operational Safeguard 4 requirements

VIII.3.1.2.2. Impacts on the soil quality and resources in surface and underground waters

In the operation phase, the main impacts on soil and water relate to pollution which is likely to be caused by the various activities of the plant.

In fact, the handling of fuel oil (transport, unloading, storage, etc.) used as fuel can lead to contamination of the soil, subsoil, surface and groundwater, by accidental spillage or leakage.

The activities related to the operation will require the use and storage of oils (110 m^3) for the operation and maintenance of the plant. These activities can lead to contamination of the soil, subsoil and surface water by accidental spillage or leakage of hydrocarbons, oils, etc. They can also contaminate groundwater by infiltration.

Plant maintenance and cleaning activities (buildings, roads, etc.) are also likely to produce pollution of soil, surface and groundwater by infiltration. In fact, poor management of wastewater, washing water and waste generated by these aforementioned activities can lead to deterioration of the quality of the soil and, by infiltration, contaminate groundwater.

In summary, the products likely to cause pollution of soil, surface water and groundwater by infiltration are: used oils stored or transported, new oils stored or transported, various washing waters, fuels stored or transported; saturated sludge and chemicals (sulfuric acid, lye, etc.).

However, fuels and oils will be stored in sealed tanks with overfill prevention systems and leak detection systems. As for the unloading area, it will be arranged so as to be able to recover and evacuate liquids in the event of a leak. In addition, the tankers to be used will be subject to prior technical inspections.

VCE	Disturbance	Intensity	Extend	Duration	Importance
High	Low	Moderate	Local	Long	Moderate

<u>Reduction measures</u>

According to the recommendations of the ADB Operational Safeguard 4 which deals with the rational use of resources and pollution prevention, to avoid or limit and control discharges.

Other recommendations are also listed below:

- collect runoff according to the various works used to contain it and control its quality before any discharge or recycling;
- implement a rainwater management plan;
- provide a mini station to treat loaded water;
- request the services of an approved company for the collection of black water;
- treat water likely to be affected by oil;
- comply with NS 05-061standard on wastewater before any effluent discharge;
- recycle treated wastewater if possible;
- use containment basins or watertight containment tanks for the storage of chemicals;
- unpacking and handling fuel oil on fitted and waterproof surfaces;
- implement a facility inspection and maintenance program;
- put in place intervention procedures in the event of an accidental spill or leak;
- implement an Internal Operation Plan (POI) to deal with emergency situations;
- apply preventive and protective measures;
- sort and then store waste in a sealed storage area;
- regularly monitor solid and liquid waste likely to be polluting;
- find approved channels for the transport, storage and disposal of waste;

- carry out periodic tests (hydraulic and tightness) at regular intervals to verify the good condition of the tanks and the proper functioning of the trucks.

With the application of these mitigation measures, the significance of the impact on soil, surface and groundwater could be considered low.

VIII.3.1.2.3. Impacts on the water resources used by the populations

The plant's water needs during the operating phase have not yet been estimated. However, water will be supplied by drilling which will be carried out on site.

Water needs will be mainly linked to:

- water required for cleaning equipment, installations and industrial activities;
- water required for the fire circuit;
- drinkable and sanitary water for human use.

During the operational phase, the recruitment of 50 employees is planned. So the amount of water necessary for the satisfaction of sanitary needs is estimated between 01 and 2.5 m^3/d.

The installation of a 500 m^3 raw water tank, a demineralized water storage tank of 80 m^3 and a tank of 1000 m^3 of water for the fire network are also anticipated.

The withdrawal of this water to meet the needs of the plant is unlikely to have a significant impact on the aquifer. In fact, the hydrogeological studies carried out for the feasibility of drilling have shown that the aquifer, which will be exploited, is productive (**aquifer from the freshwater clay sands of Maastrichtian)**. Thus, the significance of the impact is considered to be moderate.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Local	Long	Moderate

<u>Reduction measures</u>

The study recommends the following mitigation measures to minimize the impact of the project on water resources:

- collect and use rainwater for watering green spaces;
- implement a rational water management policy;
- put signs at the level of the toilets and sinks, to raise awareness among employees and visitors on the importance of water conservation;
- favor self-closing taps;
- promote preventive maintenance of pipes and water points (taps, flushes, sinks…);
- repair any damage that could cause a water leak in time;
- set up a piezometer fitted with an automatic data logger for better monitoring the condition of the water table.

The plant operator will also have to implement consumption reduction measures in accordance with the requirements of ADB Operational Safeguard 4. With the application of the above measures, the significance of the impact will go from moderate to low.

VIII.3.2.On the biological environment

VIII.3.2.1. During the construction phase

VIII.3.2.1.1. Impact on the flora and fauna

The site preparation and development work will inevitably lead to deforestation materialized by activities of slaughter, weeding and brush clearing of the plant species currently present on the site.

It is noteworthy that this vegetation identified on the site serves as a shelter, nest box, resting site but also constitutes a feeding station through its seeds, its fruits as well as the insects living there.

The construction work, as well as the presence of labor will impact on the flora and micro fauna present on the site. Hence, the release of the right of way will lead to the disappearance of the vegetation but also a disturbance of the micro fauna due to the noise generated and the human presence.

In addition, during this phase, several types of waste (cuttings, used oils, plant debris, construction waste, etc.) will be generated on the site. The risks of pollution following an accidental spill or a leak of dangerous products can be noted. Plant species, small mammals and reptiles (rodents, lizard, salamander, monitor lizard, snake, etc.) can be very sensitive to certain pollutants. In addition, a risk of falling small fauna (small reptiles or rodents) in excavations opened during foundations can be noted during the works.

In summary, construction of the power plant could lead to the disappearance or degradation of vegetation and a temporary disturbance of the micro fauna. However, the site is very strongly marked by human presence, with cultural practices not very conducive to the conservation of natural vegetation.
In fact, the site is not very rich in vegetation as only one plant species (baobab) with partial protection status has been identified on site.

VCE	Disturbance	Intensity	Extent	Duration	Importance
Moderate	Low	Low	Punctual	Short	Very low

<u>Compensation and reduction measures</u>

AfDB Operational Safeguarding 3 recommends conserving biological biodiversity and promote the sustainable use of natural resources. In order to minimize the potential impact on the flora and fauna, the company in charge of the works will implement the following recommendations:

- limit the site's footprint to the strictly necessary surface;
- use machines, vehicles and equipment that meet standards in terms of sound emissions and raising staff awareness;
- prevent the wandering of animals inside the site;
- if necessary, use small mesh screens to prevent small animals from falling into open trenches;
- respect the administrative procedure before any action on the flora. For this you will need to:
    - contact the Municipal Council of the Municipality to establish the baseline situation found on site;
    - establish a clearing request;
    - contact the IREF to report on the baseline situation found on place and have the technical opinion on the methods of felling trees;
- ensure that plant losses are reduced to the strict minimum;
- avoid the accidental or deliberate introduction of exotic species which may modify the natural plant characteristics in the project area;
- ensure, in collaboration with IREF, the compensation for plant losses through reforestation;
- compensate (in collaboration with the IREF) for the loss of wildlife habitats by stocking native species in a nearby area with similar ecological characteristics;

- avoid impacts on habitats outside the perimeter by precisely delimiting work and traffic areas (mark the site);
- set up an effective management system for construction waste and have a pollutant recovery system on the ground (in the event of a spill);
- replace the vegetation destroyed by native species in order to ensure in the medium or long-term replacement of these habitats;
- implement a reforestation plan and ensure follow-up in collaboration with the Mbour forest sector.

VIII.3.2.2. During operation phase

VIII.3.2.2.1. Impacts on the flora and fauna

During the operational phase, the main potential impacts will be linked to noise generation due to the operation of certain plant equipment in addition to the noise generated by machines and vehicles, but also by the presence of personnel. It will also be noted the production of several types of hazardous waste.
The visual impact due to the presence of unnatural elements in the landscape (42m chimneys) can constitute annoyance for avian fauna, as well as the lighting of the plant.

These noise, waste and plant lighting annoyances are considered disturbance to wildlife and birds.

As the project area is not very rich in vegetation and wildlife resources, the significance of the impact is considered to be low.

VCE	Disturbance	Intensity	Extent	Duration	Importance
Moderate	Low	Low	Local	Long	Low

<u>Reduction measures</u>

The recommendations below should be taken into account during the exploitation phase to reduce the impacts on the biological environment:

In order to make the impacts insignificant, the study recommends the following measures:
- avoid the wandering of animals in the plant;
- set up a buffer zone between the plant and the natural areas;
- avoid the proliferation of rapidly growing exotic species;
- ensure the reduction of engine noise by means of maintenance and technical regular visits;
- create green spaces inside the plant;
- carry out reforestation campaigns.

VIII.3.3.On the human environment

The installation of Malicounda power plant with a capacity of 120 MW will have impacts both the construction phase and the operation phase.

VIII.3.3.1. Positive impacts

During the construction and installation phase of Malicounda plant, positive effects on the human and socio-economic environment of the project area will occur.

VIII.3.3.1.1. Positive impacts during the construction phase

During the construction period, the plant will mobilize labor from different geographic horizons in the country. Indeed, the construction of the power plant will call on different expertise ranging from masonry trades to electrical and mechanical engineering. Therefore, the establishment of this plant will induce positive externalities on the site and its environment, summarized as follows.

- **Job creation**

The construction of the plant requires the recruitment of qualified and unskilled labor ranging from security to electrical engineering, civil and mechanical engineering.

Over 400 people will be recruited, which will help reduce the unemployment rate throughout the country, particularly at the level of the project reception area.

The environmental value of this impact will be great because employment is a vital element for an emerging economy. The significance of the impact is deemed to be strong.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Moderate	High	Regional	Short	High

Improvement measures

To optimize this positive impact, it is necessary to:

- involve the Regional Labor Inspectorate for the identification of workers;
- favor the hiring of PAPs through positive discrimination;
- favor local populations, particularly people with low incomes for unskilled jobs (local labor, cleaning, security, etc.) and ensure their continuing training;
- create a local recruitment committee based at the commune level.

- **Development of new economic activities around the site**

The presence of permanent workers on site during the construction phase will promote development of income-generating activities.

These activities include small businesses and catering, especially involving the labor of female labor throughout the work duration.

Adding to this, the region would have urban and peri-urban transport which will be more developed with staff displacement.

The environmental value is considered to be high because the site will have a positive impact on the local economy. The significance of the impact will be moderate.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Moderate	Moderate	Local	Short	Moderate

Improvement measures

The application of the measures below could enhance these positive impacts:

- develop and secure spaces that will host these new activities (small restaurants, shops, etc.);
- allow local populations to increase their income by promoting them for the development of these new activities.

- **Business opportunities for private economic operators**

The assembly of the plant can be done by SMEs specializing in sheet metal work, electricity, electro mechanics and other trades that will take care of site development, building construction and equipment installation operations. These activities will be carried out under the supervision of an EPC (Engineering Procurement and Construction). The start of the project remains a business opportunity for construction, technical control, general mechanics, boiler making, electricity, etc.

Even if the duration is short, the positive impact induced remains major (strong).

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Moderate	High	Regional	Short	High

Improvement measures

The implementation of actions listed below could enhance these positive impacts.

- develop subcontracting so that local small businesses can gain market share and experience;
- conduct training sessions to build the capacity of these local businesses.

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VIII.3.3.1.2. Positive Impact during the operation phase

The operation of the plant is a major economic, social and environmental challenge.

The positive impacts induced by the operation of this power plant are listed below.

- **Job creation**

Operation of the plant will require the hiring of 50 to 60 permanent employees and qualified and unskilled temporary employees. These employees will be made of engineers, technicians, drivers, etc.

In addition, throughout the life of the plant, SMEs, large repair and maintenance companies, suppliers of spare parts and other services will work with the plant as part of its maintenance, lasting at least two to three months a year. During this period, providers will also be engaged, a good part of which will be made up of local businesses.

This recruitment contributes to reducing the unemployment rate and contributes to strengthening the policy of the State of Senegal, in this case the PES, one of the objectives of which is the creation of jobs. So this would be deemed of a high importance.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Regional	Long	High

Improvement measures

Optimizing these impacts related to job creation requires:

- involving the local community in staff recruitment procedures;
- promoting local employment training for recruitments to upgrade them, and provide continuous training for recruited to upgrade them;
- developing a modern social policy for staff members.

In addition, the project company must comply with Operational Safeguard 5 which defines the ADB requirements relating to the conditions of workers, their rights and protection against ill-treatment or exploitation.

- **Reinforcement of the energy sector and development of an energy hub**

The injection of electrical energy production from the new 120 MW power plant on the SENELEC network will reduce the energy deficit recorded in the country.

An increase in the production of electrical energy will facilitate electrification and reinforcement of security by improving the public lighting of certain rural and peri-urban areas thus far excluded.

In addition, the installation of the thermal power plant operating on heavy fuel oil in Malicounda will make the area an energy hub where energy production will be done through various sources such as solar (Malicounda solar power plant).

The value of the environmental component is considered to be great because in addition to strengthening the energy sector, the Municipality of Malicounda would have a special status because it constitutes a very strategic energy center in the country. The importance of the impact is very high.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	High	Very high	Regional	Long	Very high

Improvement measures

These recommendations below will improve the impacts:
- involve the authorities of SENELEC in the management policy of the plant;
- strive for total coverage of the municipality and its villages in terms of electricity supply;
- worry about the energy efficiency of power plants;
- study the possibilities of reducing costs linked to electricity in the Municipality of Malicounda.

Increase in revenue for the commune

The project will promote the industrial fabric of the Municipality of Malicounda and will be accompanied by direct and indirect financial benefits for the municipality, its population, and the residents of the site.

During the entire operating phase, Malicounda thermal power plant will be subject to the payment of municipal taxes. Thus, the importance of the induced impact will be considered strong.

VCE	Disturbance	Intensity	Extent	Duration	Importance
Grande	Moderate	High	Local	Long	High

Improvement measures

The recommendations below will improve the impacts:
- allocate a share of the investment to subsidize community projects;
- establish the technical management of the contracting company for the power plant in the Municipality of Malicounda.

VIII.3.3.2. NEGATIVE IMPACTS

VIII.3.3.2.1. Negative impacts during construction phase

Although producing positive impacts, the construction of the power plant in the Municipality of Malicounda will also have negative impacts. They are analyzed in the following paragraphs.

Loss of agricultural land and plots

In and around the site, subdivisions and some buildings under construction have been identified. During the preparatory work, it becomes clear that these previously allocated plots will be subject to involuntary displacement, which constitutes an irreversible loss of assets for the owners who had to invest in their acquisition. The same will apply to the owners of the buildings under construction which will be demolished.
The project right-of-way is occupied by farmers who grow millet, peanuts, cowpeas and in a lesser measure bissap and corn.

In the construction phase, all these activities will disappear on the 18 ha planned for the establishment of the power plant. In addition, producers or farmers will lose their land, which is their main source of income.

However, in accordance with ADB Operational Safeguard 2, the promoter must ensure fair and equitable compensation for PAPs who lost land with the advent of the project and the implementation of a resettlement which improves the standard of living and overall livelihoods. It is emphasized in the ESIA that SENELEC will ensure compliance with this SO and pay the compensation to the persons concerned through a RAP which will be carried out following this ESIA.

Thus, the disturbance on the environment will be average due to the permanent loss of land and the geographic displacement of agricultural activities. The significance of the impact is considered high.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Moderate	High	Local	Long	High

Reduction measures

The implementation of the following measures will mitigate the impacts:

- mobilize the Departmental Commission for Census and Evaluation of Expenses (CDREI) for the development and execution of the RAP;
- identify and compensate producers and beneficiaries of plots;
- put in place measures to support PAPs beyond compensation;
- promote positive discrimination of PAPs in the hiring of qualified staff and not qualified through permanent contracts or CDI;
- provide the restoration of livelihoods for the PAPs by facilitating their retraining;
- allocate new land to farmers and plot holders.

- **Densification of road traffic**

Road traffic will be denser during the construction phase of the plant. In fact, the project site is linked to the N1 national road by a tarmac road; the frequency of road traffic is relatively low.

With the construction of this power plant, traffic on this section will be heavier with the displacement of employees, and the supply of construction materials to the site. In addition, traffic disturbances will be observed following the rotation of trucks and vehicles for the transfer of equipment and, excavation and removal of spoil between the Landfall and the site.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Moderate	High	Local	Short	Moderate

Reduction measures

These recommendations suggested below will reduce these negative impacts caused by the densification of road traffic, namely:

- developing a periodic circulation plan for the delivery of materials and equipment and installing signposts in the most dangerous places;
- planning the arrival of heavy equipment;
- using a professional escort between Dakar and the site;
- using platforms and container carriers adapted to the dimensions of the equipment;
- informing the stakeholders (town halls, municipalities, populations,) of the date of the convoy (by radio, newspapers) on the routes, the risks and the measures to be taken to avoid accidents;
- using trucks in good condition and regulate the technical speed for transport at site level;
- training and educating drivers and insist on speed limits to 30 km / h at Malicounda ramp between the site and the N1 national road;
- checking the possibilities of setting up another ramp connecting the site to the national road N1.

Concessionaires networks

As the project is located in a semi-urban area, excavation and digging could have an impact on the networks of the various concessionaires (ASUFOR, SONATEL and SENELEC).

SENELEC pylons have been identified on the site and the 225 KV substation is right at their limits. These infrastructures should be the subject of particular attention during the preparation and construction of the power plant. The value of the environmental component is considered to be average due to the disturbance caused by a possible accident on this overhead and underground network.

VCE	Disturbance	Intensity	Extent	Duration	Importance
Moderate	Moderate	Moderate	Local	Short	Low

Reduction measures

The study recommends the following measures:

- notify SENELEC of the start of pre-construction activities;
- identify the exact route of the overhead and underground network.

Disturbance of the living environment

- **Noise pollution during construction**

The installation of foundations and certain work to connect the interfaces will require the use of various mobile and stationary equipment which are sources of noise. Moreover, the traffic of trucks, the use of compressors and pneumatic tools, the noise generated by the installation of equipment, etc.
These activities and equipment can generate noise pollution, which can affect the living environment of people and the natural environment.
It is noteworthy that the project will be developed in a quiet area (results of the study on the initial sound environment) and on a site close to homes (Keur Maissa Faye district). Consequently, it is important to take into account these noise disturbances which will be of an annoyance for the neighboring populations.

- **Waste generation during construction**

Site preparation work as well as the installation of plant and equipment will produce a relatively large volume of spoil, rubble and waste consisting of packaging and metals. In addition to this waste, other production of waste will be considered as dangerous, in particular used oil produced by construction machines and vehicles.

The evacuation and deposit of this waste off the site could cause impacts on the framework of life and the natural environment.
As the site is close to the first human settlements (40 m), the value of the environmental component is considered to be high and the impact is high.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	High	Very high	Local	Short	High

Reduction measures

The study recommends the following measures:

- respect the 85 dB (A) limit at 1 m for the equipment and tools used;
- carry out timely maintenance of pneumatic tools, machinery and equipment to maintain the noise level generated at an acceptable value;
- ensure the hooding of certain very noisy equipment such as site diesel engines and compressors;
- carry out work that induces noise beyond rest hours;
- collect, sort and transport waste to authorized landfills;
- educate staff on waste management;
- avoid throwing solid and liquid waste into the environment;
- carry out regular emptying of septic tanks by an approved organization;
- ensure traceability of this waste;
- water the worksite floors;
- organize the management of hazardous waste (oils, solvents, waste oils, etc.) and ensure their recovery and treatment by specialized companies in the area.

Impacts on the cultural/historical heritage

On the given site planned for the construction of the power plant, no presence of archaeological site, historic monument, place of worship likely to be affected or threatened with disappearance due to the works, is noted. However, **a cemetery exists approximately 100 m from the northern boundary of the site and will require special attention.**
The value of the environmental component is considered high because of the sanctity of this place for the populations even if the importance of the impact is considered low.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Local	Short	Low

Reduction measures

The study recommends the following measures:

- close this cemetery at the start of work;
- notify the competent authorities in the event of the discovery of remains or archaeological objects during the works;
- educate workers on what to do in the event of the discovery of remains;
- avoid touching sensitive sites such as the cemetery;
- protect cultural heritage from the negative impacts of project activities.

VIII.3.3.2.2. Negative impacts during operation phase

The operation of the plant is a major challenge from an economic, social and environmental point of view. However, it might bear negative impacts on the receiving environment of the project.

Disturbance of the living environment

- **Noise pollution**

In the operating phase, the most significant sources of noise, which can disturb the surrounding environments are, among others:

- diesel engines and their cooling systems (radiators);
- air compressors and turbo-alternators;
- pumps and various rotating elements.

The plant commissioning test period will also cause noise. In fact, this short duration period will be characterized by frequent stops /starts of the groups before the assembly is put into normal operation.

The noise level around the site before the plant was installed is normal and no noise-generating activity has been particularly identified in the area.

Therefore, the preservation of this sound environment is essential. The noise level within the power plant and at the property boundary must not exceed the limits accepted by the Environmental Code.

- **Operation waste**

The plant will generate solid, semi-solid and liquid waste as described in Chapter 2 of this report. This waste will be subject to an appropriate management method which provides the collection, sorting, storage, awareness of operators and monitoring of the final destination of the waste.

The impact of this waste generated by the plant on the environment will depend on its source, its nature, the quantities likely to be produced, the management system implemented and its final destination.

The living environment, which has great environmental value, will be severely disrupted if an effective waste management system is not put in place throughout the life of the plant. Thus, the significance of the impact is considered to be strong.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Moderate	High	Local	Long	High

<u>Reduction measures</u>

The following measures are recommended in order to reduce the significance of the impact:

- put in place an effective waste management plan;
- ensuring the collection, sorting and elimination of waste;
- maintain a waste register;
- opt for recovery of used oils, greases and centrifugation sludge in a local cement plant;
- provide a mini station to treat loaded water;
- request the services of an approved company for the collection of black water;
- train and educate staff on waste management;
- equip and require that workers to wear earmuffs;
- set up a periodic maintenance program for the noisiest equipment to keep the generated noise level at an acceptable value;
- perform acoustic measurements at the property boundary and check if the maximum noise thresholds are not exceeded.

The application of the above measures will allow conformity with the Operational Safeguard ADB 4.

VIII.3.4. IDENTIFICATION OF IMPACTS ON HYGIENE, HEALTH AND PUBLIC SAFETY

VIII.3.4.1. IMPACTS ON HYGIENE, HEALTH AND SAFETY IN THE CONSTRUCTION PHASE

During this phase of preparation and construction of the plant, the multiple activities that are developed are likely to affect the physical integrity and health of the populations and workers, but also hygiene on and around the site.

- **Impacts on hygiene**

Uncontrolled garbage disposal and a lack of staff awareness can contribute to increased unsanitary conditions in and around the site.
In fact, wastewater from the construction site as well as used oil and household waste, if discharged into the environment without prior precautions is likely to pollute the environment and will affect the hygiene of the environment in question.
The value of the environmental component is high and the significance of the impact is low.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Low	Moderate	Punctual	Short	Low

- **Health impacts**

Working conditions, construction materials, manual handling, long exposure and repeated noise and sunlight are factors that can affect the health of workers.

In fact, lifting heavy loads without handling aids, restrictive work postures and repetitive movements can cause bodily harm and occupational illness.

Cement dust can be responsible for eye conditions. Moreover, we have skin toxicity of cement which induces many dermatological problems for example: dermatitis irritations, allergic dermatitis.

Prolonged exposure to the sun is associated with risks of general discomfort, muscle cramps, loss of consciousness, which can be vital in extreme cases (heat stroke). Indirectly, work in hot weather also increases the risk of accidents at work through fatigue, sweating and reduced alertness.

Unhealthy and unhygienic premises and surroundings due to poor waste management can affect the health of workers and populations.

VCE	Disturbance	Intensity	Extent	Duration	Importance
High	Moderate	High	Punctual	Short	Moderate

- **Security impacts**

The working processes as well as the materials and equipment necessary for the construction of the plant represent risks to operators. Work at height with unsuitable or poorly anchored scaffolding, overloaded, crowded or non-rigid platforms, improper use of ladders, work on fragile supports, etc. can cause falls from a height, the consequences of which may be dramatic. The simultaneous intervention of several trades in the site generates multiplied risks of "co-activity" due to interactions, misunderstandings and in comprehensions among companies, which affects site security.

Workers are also exposed to the risk of falling on the same level when equipment is collected in a disorganized manner and without signage. When handling unprotected tools, they are exposed to the risk of injury and burns.

Traffic on the site is likely to lead to car accidents (collisions, bumps, etc.)

The influx of foreigners for work needs is likely to affect the security of populations.

The environmental component is great and the significance of the impact is medium.

VEC	Disturbance	Intensity	Scope	Duration	Significance
Great	Medium	Strong	Punctual	Short	Medium

Mitigation mesures

In order to alleviate the impacts on hygiene, health and safety, the following measures are recommended to be applied:

- ensure sorting and proper disposal of worksite waste and make a daily follow-up;
- provide workers with sufficient drinking water;
- provide workers with adequate, hygienic and gendered toilets;
- provide watertight pits for collecting sewage;
- educate workers on the importance of maintaining hygiene on the site;
- appoint one or more HSE managers to protect and prevent occupational risks;
- avoid as much as possible the use of manual handling including risks of injury;
- train workers on load handling techniques;
- provide workers with handling and lifting equipment;
- provide workers with PPE adapted to their work station;
- limit the speed of movement of vehicles;
- cover or protect temporary stocks of powdery materials from the wind;
- put products that could pollute the soil and water under retention;
- avoid uncontrolled burning of waste and storage in uncontrolled landfills;
- provide the population and workers on the site with a medical unit for the surveillance and management of ARI;
- require workers to wear PPE and respect collective protection barriers;
- make workers and drivers aware of the importance of keeping them safe on site;
- establish a plan and traffic rules on the site;
- train operators and drivers to drive safely;
- keep the site clean and organize the storage well;
- establish a schedule for the execution of simultaneous or successive works;
- before using any equipment, make sure it is in good condition;
- put hazard pictograms, protective beacons and prohibition and signaling signs in all places where there is a risk;

- carry out information and awareness campaigns.

VIII.3.4.2. IMPACTS IN OPERATION PHASE

With the implementation of the power plant, mechanical or technical organizational failures could have multiple impacts on the health, hygiene and safety of workers and spread to the residents and to the environment external to the site.

- **Impacts on hygiene**

The operation of the power plant will lead to hygiene problems if, however, not all measures are taken to maintain sanitation in the premises. If the waste generated (sewage, sludge, household waste), are discharged into the environment without prior sorting or precautions, it is likely that it will pollute the environment and affect the hygiene of the concerned environment.

The value of the environmental component is great and the significance of the impact is medium.

VEC	Disturbance	Intensity	Scope	Duration	Significance

Great	Low	Medium	Punctual	Long	Medium

- **Impact on the health**

The operation of the power plant requires chemicals, noisy equipment and emits smoke and hazardous waste. The work processes as well as the products and materials used are likely to affect the health of workers and surrounding populations. Some equipment used in the electricity production process are very noisy. Frequent and prolonged exposure to this noise can cause hearing damage.

Exposure to dangerous products (heavy fuel oil, light fuel oil, etc.) may cause by inhalation or skin contact, lung diseases, dermis or burns. It can also cause occupational diseases.

Temperature differences can cause thermal shock, while working in confined spaces can lead to anoxia.

The burning of fuel oil gives off toxic fumes which are a source of respiratory ailments for everyone exposed (worker, population).

The value of the component is great and the significance of the impact is very strong.

VEC	Disturbance	Intensity	Scope	Duration	Significance
Great	High	Very strong	Local	Long	Very strong

- **Impact on the safety**

The operation of the power plant requires equipment and installations at risk that could cause injury, burns, explosion, fire, etc.

When handling electrical installations or equipment, workers are exposed to the risk of burns, electric shock or even electrocution.

Handling fuels or working in ATEX areas involves chemical, toxic and explosion risks.

Welding and maintenance operations involve the risk of physical harm such as injury and burns.

Internal distribution as well as fuel convoy can lead to distribution accidents.

In case of a fire or explosion, the effects of which go beyond the limits of the power plant, public safety will be at stake. Daily refueling is also a risk factor for the populations of the areas crossed because it is likely to cause road accidents.

The value of the environmental component is great and the significance of the impact is strong.

VEC	Disturbance	Intensity	Scope	Duration	Significance
Great	Medium	Strong	Local	Long	Strong

Mitigation measures

In order to alleviate the impacts on hygiene, health and safety, the following measures are recommended to be applied:

- take into account the general principles of prevention in health and safety at work;
- provide a cleaning team to permanently ensure the hygiene of offices, toilets and public spaces inside the power plant;
- provide separate low flow sinks for men and women at the rate of one faucet with running, clean water for ten (10) workers;
- install these sinks near work or catering places;
- provide separate toilets for men and women;
- establish an HSE committee and appoint a manager;
- establish a reliable drainage system to avoid the discharge of used or contaminated water;
- implement a waste management policy and prioritize recycling or reuse if possible;
- do a medical examination before hiring;
- provide the workers concerned with the SDS (Safety Data Sheet) of the products handled;

- train workers in first aid techniques according to the types of risks to which they are exposed;
- carry out regular inspections as well as preventive maintenance of installations and equipment (storage tanks, retention tanks, etc.);
- appoint a health and safety coordinator and create a CHST;
- make workers aware of the importance of respecting the wearing of PPE and collective protection barriers;
- inform the populations about the probable risks and the means to protect themselves;
- Use an Ultra-Low-Sulfur diesel (ULSD) ;
- ensure the authorization of tanker truck drivers;
- make the population aware of the precautions to take when transporting fuel;
- take into account the wind direction when installing the power units and chimneys;
- establish a schedule for the execution of simultaneous or successive works;
- check the installations and devices before implementation;
- inspect work equipment every three months and after any accident or incident or as soon as an abnormality is noticed;
- put up signs indicating the nature of the danger and the prohibitions in all the places requiring it;
- identify ATEX zones and put in place rigorous safety instructions;
- set up safety showers and eyewash stations near places where dangerous products are handled;
- prohibit intervention on any equipment in operation or presenting risks for maintenance or repair works;
- provide a guard station equipped with competent staff.

VIII.3.5. CUMULATIVE IMPACTS

VIII.3.5.1. IDENTIFICATION AND DESCRIPTION OF CURRENT AND FUTURE PROGRAMS OR PROJECT

In the project area, current and future projects have been identified and could contribute substantially to the cumulative environmental effects. It concerns:

- the Malicounda solar power plant with a power of 22 MW which is built on an area of 100 ha and which has been operating since 2016;
- the 225 kV HV substation at Malicounda and the presence of functional HV lines;
- the toll highway project planned at 25 m from the project right-of-way and whose base is already in place at the time of the study.

VIII.3.5.2. IDENTIFIED NEGATIVE CUMULATIVE IMPACTS

- **Loss of Land**

The allocation of the 18 ha for the needs of this project comes on top of the losses suffered by the local populations due to the installation of the power plant. This contributes to the loss of lands of the municipality.

Furthermore, it results in a loss of assets and income which means that this impact can be considered to be strong. However, the mechanisms implemented within the framework of a fair and equitable compensation process and in the implementation of a Resettlement Action Plan incorporating a Livelihood Recovery Plan (PRMS) could significantly reduce the impacts linked to these land losses.

- **Deterioration of the air quality**

The operation of the power plant could cause the deterioration of the air quality through the emission of pollutants mainly linked to the use of heavy fuel oil.

In addition to this, the increase in traffic due to the implementation of the future toll highway will encourage the emission of air pollutants from vehicle's tailpipes.

On the other hand, electrical stations contribute to the deterioration of the air quality by the release of sulfur hexafluoride (SF6) which is a gas used for the protection of electrical circuits and installations. This chemical compound is a powerful greenhouse gas covered by the Kyoto Protocol.

All these cumulative effects, concentrated in this same area, which was once non-industrialized, will significantly contribute to the deterioration of the air quality and the production of greenhouse gases, which will have direct repercussions on the population's health. Thus, measures to reduce air pollution must be taken for each project, in particular the one subject of this study.

- **Disturbance of the flora and fauna**

At the instigation of human action, a large part of the natural ecosystem of the project area was transformed into crop fields, which was the source of an intense loss of animal and plant biodiversity. The construction phase of the power plant will cause the clearing and deforestation of the few remaining species. In addition, there are similar activities which took place during the construction of the solar power plant and which will probably be repeated for the needs of the construction of the toll highway.

In addition to this massive deforestation in an area where biodiversity is to be preserved, there is the loss of habitats and wildlife that used lived in these trees and, more particularly, certain species of nesting birds. This destruction of flora and fauna habitats contributes to the deterioration of the natural ecosystem which is an environmental component to be preserved, especially in these times, when global warming as well as the emission of greenhouse gases are increasingly more preponderant. A reforestation campaign should be essential for any project requiring the cutting of trees or having a negative impact on flora and fauna.

- **Presence of HV lines**

The project will involve the construction of HV lines which will be added to those set up to transport the energy produced at the Malicounda solar power plant.

The increase in pylons and suspended lines is a negative visual impact and favors the increase in electromagnetic fields generated by HV lines. In addition to that, the increase in the electrical risk due to these HV lines which, through anthropogenic or natural phenomena, can create disasters (fire, electrification, electrocution, etc.) and thus damage the health and safety of workers and populations. Respect for rights-of-way as well as safe distances is essential to mitigate these cumulative effects due to the increase in electrical installations in the project area.

- **Increase in traffic**

The construction and operation of the Malicounda thermal power plant requires a large flow of vehicles for the transportation of equipment as well as for the fueling. This increase in traffic will be even more accentuated by the implementation of the toll highway, the construction works of which have already started.

With these two projects, in addition to the current traffic, road traffic will probably become very dense in this area, which will have consequences for the environment, health and the living environment through the emission of smoke from gases vehicle exhaust and noise generation.

There will also be a safety issue with the many risks of car accidents that can occur.

These accidents can nevertheless be minimized by respecting the regulatory distances between roads and first dwellings, putting up signs and respecting the code of ethics.

- **Noise generation**

In the operating phase, the power plant will generate noise from various sources identified in the project description.

At the toll highway, a relatively high noise level will be observed linked to the noise caused by the passage of vehicles and increased traffic.

These two important factors, combined with the noise generated at the electrical substations (noise coming from the fans installed on the oil radiators and the movements of the windings), will significantly contribute to the increase in noise levels in the area. The proximity of the first dwellings is a factor accentuating the importance of the impact of noise which must be properly taken care of by the installation of anti-noise devices at the power plant level and the relocation of dwellings located less than 260 m from the site. Thus, the impact is judged to be insignificant.

VIII.3.5.3. POSITIVE CUMULATIVE IMPACTS

- **Increase in electricity production**

The simultaneous operation of the two (02) power plants will allow injecting on the interconnected grid of 22 MW and 120 MW respectively for the Malicounda solar power plant and the Malicounda thermal power plant. This surplus in the SENELEC network will allow a significant reduction of the energy deficit which will result in an improvement of the living conditions of the populations who will register a higher rate of access to electricity.

- **Job creation**

The advent of these projects in the area will generate a lot of jobs that will benefit the youth, especially those in the locality. In addition to the jobs that will be created, business opportunities must be seized for the subcontracting companies and those which supply the building materials.

These job opportunities offered by these different projects will help reduce the unemployment rate as well as improve the living conditions of local populations and all those affected.

- **Promotion of the area**

These various projects, vectors of development that revolve around Malicounda, will offer this locality greater visibility, especially in terms of business opportunities for investors. These projects will be favorable to the municipality because the development of the area rhymes with the payment of municipal taxes, generation of jobs, creation of resources and wealth for the emergence of the country.

These new investments must, however, be managed, meet the environmental requirements as well as the development policies established and above all, be compatible with already existing projects so as not to further damage the environment and cause inconvenience to the populations.

IX. RISK ASSESSMENT

IX.1. INTRODUCTION

IX.1.1. OBJECTIVES

A power plant is an industrial site intended for the production of electricity. It requires risky installations, equipment and processes which could have harmful effects on the environment and on individuals.

This risks study is carried out with the aim of understanding the technological and environmental risks likely to occur and affecting the power plant and its immediate environment. Thus, the objectives of this risk analysis are to make a prediction on all accidents and incidents that may occur during the construction phase as well as during the operation of the power plant. Thereafter, means of prevention, protection and intervention will be proposed in order to reduce the probability of occurrence of dangerous phenomena and to mitigate the gravity of the consequences which could result from it.

IX.1.2. EXPECTED RESULTS

In accordance with the Methodological Guide of the Study of Risks of the Ministry in charge of the environment of Senegal, the objectives of a risks study can be summarized as follows:

- serve as a reference for decision-makers for taking safety measures into account;
- identify the challenges and potential risks;
- Analyze the risks;
- Asses the consequences;
- propose means of prevention, control and intervention;
- allow risk reduction inside and outside the establishment;
- provide the basic elements necessary for the development of the IOP;
- contribute to staff information and awareness;
- develop a risk culture among employers, employees and populations.

In summary, the risks study makes it possible to develop a risk prevention policy towards the public and personnel of the power plant.

The results of this study will serve as a guide for decision-makers in order to take the necessary measures for the design of suitable premises and the implementation of preventive, protective and alert means in order to be able to anticipate any unfortunate event to come.

IX.1.3. ACHIEVEMENT METHODOLOGY

The structure of the risks study report follows a chronology allowing to identify all the potential risks contained in and around the power plant. This makes it possible to characterize all the possible risks and to study their effects on the environment in order to make a good forecast on the probable damage.

IX.2. DESCRIPTION OF SITE ENVIRONMENT

IX.2.1. NATURAL ENVIRONMENT

The characterization of the natural environment allows to identify natural phenomena liable to cause damage to installations.

IX.2.1.1. CLIMATE CONDITIONS

- **Temperature**

The average annual temperature recorded at the Mbour station is 27.3 ° C. Average monthly temperature values range from 25 ° C (January) to 28.7 ° C (October).

- **Relative humidity**

The maximum is recorded in September with 84.4% and the minimum in January with 49.8%.

The most important values are recorded during the rainy season between June and October.

- **Rainfall**

The rainy season lasts 4 to 5 months in the area and settles from the end of June / beginning of August and ends from the month of October. Over a period of 30 years, the average annual rainfall is 610.7 mm.

In 2016, the average rainfall recorded in the area was 952.9 mm. The rainfall this year is excessive because it exceeds the average.

- **Wind**

Over a period of 30 years (1987 to 2016), the average monthly wind speed is 2.7 m/s. The maximum speed is recorded in April (3.2 m/s). The highest speeds are recorded during the dry season. From November to April, the prevailing winds are north, northeast. However, from May to October, the prevailing winds are from the west.

IX.2.1.2. HYDROLOGY AND HYDROGEOLOGY

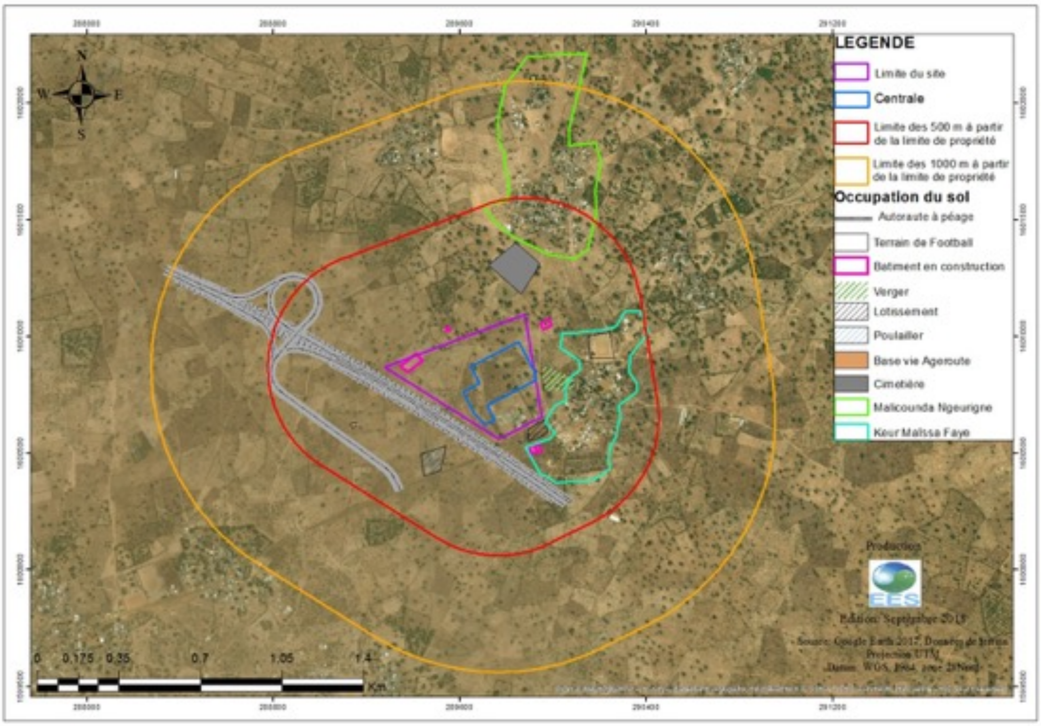
In the Municipality of Malicounda, the aquifers operated by the boreholes are those of the Maastrichtian and the Paleocene which are at depths of more than 100 m.

IX.2.1.3. GEOLOGY

The power plant site is located on tropical ferruginous soils that are not or are slightly leached or "Dior" soils. These soils are well drained thanks to their sandy materials which facilitates infiltration and reduces the risk of flooding.

IX.2.2. ANTHROPIC ENVIRONMENT

The general environment of the site is described to be able to identify external human activities likely to interact with those of the power plant. The project site covers 18 ha; however, the power plant will be located on around 06 ha inside the site. The site is located in an area where urbanization is starting to develop strongly. On a radius of approximately 500 m around the site, dwellings, communication channels and orchards have been identified.



Map 9 : Immediate Environment of the Site

<u>Legend</u>: Limit of the site/power plant/500 m limit from property boundaries/1000 m limit from property boundaries/Land occupation/Toll road/ Football playground/Under construction building/Orchard/Housing estate/Hen house/Life base of Ageroute/Cement industry/Malicounda Ngeurigne/Keur Maissa Faye

IX.2.2.1 RESIDENTIAL AREAS

The site intended for the construction of the thermal power plant is close to dwellings. The nearest, most urbanized location is the east of the site, and the nearest dwellings are approximately 40 m from the site and 150 m from the power plant. There are housing estates almost 20 m south of the site. Reported to the power plant, these housing states are 195 m apart.

IX.2.2.2 ACTIVITY AREA

The site is located in an area where people predominantly practice agriculture. Virtually, all of the available lands located at the north and west of the site are farms. Malicounda solar power plant is located 1 km east of the site. The base of the company in charge of the construction of the toll highway is at 124 m west of the site.

IX.2.3 BUILDINGS RECEIVING PUBLIC

In the wider area of influence of the study site, there are primary schools, mosques, etc.

IX.2.4. TRANSPORTATION NETWORKS

IX.2.4.1. ROAD NETWORK

There is a paved access road 55 m south of the site and about 233 m from the power plant. The construction of a toll highway is planned, the route of which passes approximately 118 m west of the power plant.

IX.3. DESCRIPTION OF EQUIPMENT AND METHODS

IX.3.1. USED RISK MATERIALS AND EQUIPMENT

The materials, equipment and installations necessary for the operation of the power plant are listed with their characteristics in the table below.

Table 59: List of materials, equipment and installations present

Designation	Utility	Characteristics	
Engine	Fuel oil to produce heat	Number	7
		Unit power	18MW
		Used fuel	Heavy fuel oil
		Chimney height	42 m
Recovery boiler	Steam production for the supply of the steam turbine	Number	7
		Thermal power	4716 KW
		Boiler volume	6.5 m^3
		Tank volume	6 m^3
		Pressure/ temperature	15-26 bars/350 ^oC
Heavy fuel oil stock	Groups operation and Stock in case of deficiency	Location	Storage area
		Numbers of tanks	3 x 3000 m^3
			2 x 5600 m^3

Designation	Utility	Characteristics	
		Supply mode	Tanker trucks
Light fuel oil storage	Stock in case of deficiency	Tanks number	1
		Tanks capacity	200 m^3
		Supply mode	Tanker trucks
substation		Number	1
		Power	225 kV
Compressor		1 compressor of 258 m^3/h at 7 bars	
		1 compressor of 185 m^3/h at 30 bars	
Demineralization station	Production of demineralized water	Number of demineralized water tanks	01
		Volume	80 m^3

IX. 3.2 USED RISK CHEMICAL PRODUCTS

The generating groups will run on heavy fuel oil but for their start-up, light fuel oil will be used. A stock of these two types of hydrocarbons is planned within the site.

Motor and dielectric oils as well as other products are used for the operation of transformers, generator groups and for the treatment and demineralization of the water.

The details concerning the utilities necessary for the operation of the machines and installations are given in the following table.

Table 60 : Nature of used products

Product	Stored quantity	Nature of the container	Storage mode
Heavy fuel oil	3x3000m^3: permanent storage 1x560m^3: buffer storage	Cylindrical barrel in stainless steel	Storage area under retention
	1x560m^3: daily storage		
Light fuel oil	1x200m^3		
Sodium hypochlorite	200 liters	Was in PVC	In storage shelters, according to their compatibility
Sulfuric acid	200 liters	Was in PVC	
Sodium hydroxide	200 liters	Was in PVC	
Citric acid	200 liters	Was in PVC	
Sodium chloride	200 liters	Was in PVC	

IX.3.3 IDENTIFICATION OF ATEX REGIONS

The ATEX regions are defined as places apt to any explosion due to the presence of explosive vapors arising from the nature of the stored product. In this oil-fired power plant, the regions likely to be classified as ATEX are located at the level of the oil storage area, and at the level of the unloading areas. However, tests must be made to circumscribe all of the ATEX areas of the power plant.

IX.3.4 PLANNED PRODUCTION SYSTEM

The electricity production system is presented in the Project Description chapter.

IX.3.5 FUNCTIONNING OF RISK INSTALLATIONS

Risky installations including, diesel generators, boilers, electrical system, storage area, etc. are also presented in the Project Description chapter.

IX.3.1. IX.3.6 HAZARDOUS GENERATED WASTE

Hazardous waste that can be generated are oily water, soiled rags, sludge produced by the decantation of fuel oil, etc. The management of this waste is presented in the chapter

Project Description.

IX.3.7. FACILITIES

The facilities allowing easy implementation of the project are vehicles, materials and equipment's delivery trucks, etc. Risks related to these facilities will be studied in the detailed risk analysis and in the study of professional risks.

IX.3.8. UTILITIES

The utilities necessary for the operation of the power plant are, among other things, compressed air for instrumentation, engine cooling water, the water supply system and the fire circuit.

The risks related to these utilities will be studied in the preliminary risk analysis.

IX.4. IDENTIFICATION AND CHARACTERIZATIONS OF POTENTIAL DANGER

IX.4.1. SOURCES OF EXTERNAL DANGER

IX.4.1.1. NATURAL EXTERNAL DANGER

Natural phenomena such as rain and wind can cause or accentuate the effects of a possible accident.

- **Wind**

The wind actively participates in the dispersal of smoke escaping from the chimneys of the generator sets. However, if this smoke is charged with particles and is harmful, it can be carried to several places on the site. By a phenomenon of diffuse pollution, the air quality of the towns affected will be degraded and this could have as consequences respiratory and pulmonary diseases. The most vulnerable layers are children, the elderly and the sick people.

The average wind speed in the locality is not very important but that does not prevent a dispersion of the smoke.

- **Rain and floods**

By a runoff phenomenon, the rain could lead to contaminated soils (if however, there is a spill of fuel oil or other chemicals on the ground) towards the natural outlets if however, a system of rainwater collection is not planned by the project. This pollution of water by hydrocarbons can have serious consequences on surface and underground water.

The rainfall recorded in the area in 2016 is a surplus, but the soil encountered is of the "*Dior"* type. It is porous and has an effective infiltration capacity so as to avoid stagnation of the waters which can enhance floods.

IX.4.1.2 UNNATURAL EXTERNAL DANGER

Unnatural external danger is thought to be due to human activities. The power plant will be located in a partially inhabited area which is likely to be heavily urbanized over time. Acts of vandalism, malicious acts, theft can lead to serious consequences because most often people who embark on these attempts do not control the risks to which they are exposed and the harmful consequences of their acts. The unconsciousness of the population and the lack of information could lead them to take actions that could harm them.

IX.4.2. INTERNAL DANGER SOURCES

Risks that may arise from activities associated with the power plant are due to the operation of the facilities, refueling activities, traffic, generated releases and waste.

The operation of the power plant may generate technological risks as well as health risks.

IX.4.2.1. CHARACTERISTICS OF THE PRODUCTS USED

The physicochemical characteristics of the products used are identified below on the basis of their SDS.

IX.4.2.1.1. Physicochemical characteristics of heavy fuel oil

- **Description**

Heavy fuel oil is a petroleum-derived fuel which is used in this specific case for combustion for the production of energy. It will undergo a preliminary treatment before injection into the engines.

- **Physicochemical properties**[99]

Physical state: Viscous liquid	Flash point:> 60 °C
Color: Brown / black	Vapor pressure: 0.02 to 0.791 kPa at 120 C
Smell: Oily	Melting point /pour point: <30 °C (<86 °F)
Exposure limit value: not applicable	Boiling point: 150 to 750 °C

- **Decomposition**

Decomposition products may optionally include the following materials: carbon oxides, nitrogen oxides, sulfur oxides, aldehydes, hydrocarbons.

- **Incompatibility, reactivity**

The product is stable and no specific reactivity testing data is available for it or for its components.

Under normal conditions of storage and use, no hazardous reaction will occur and no hazardous decomposition products should appear. This product is incompatible with oxidizing materials.

- **Toxicity**

Heavy fuel oil has acute inhalation toxicity and is carcinogenic. It is toxic for reproduction (fertility, fetus).

- **Potential Health and Environmental Effects**

This product is very harmful by inhalation and may cause cancer. It is harmful to pregnant women because it can cause serious effects in the baby. In case of prolonged skin contact, it can cause dryness or cracking of the skin. It is very toxic to aquatic organisms and can cause long-term adverse effects.

xi.4.2.1.2. Physicochemical characteristics of light fuel oil

- **Definition**

Diesel fuel is a complex combination of hydrocarbons obtained by distillation of crude oil. It consists of hydrocarbons whose number of carbons is mainly in the C9 - C20 range and whose boiling point is approximately between 150 °C and 380 °C.

Diesel will be used to start the generator sets. This product may form flammable mixtures in the air when heated above the flash point. In the presence of hot spots, there are particular risks of inflammation or explosion, under certain conditions during accidental vapors release or leakage of pressurized product.

- **Physicochemical properties**

Physical state: liquid at 20 °C	Vapor pressure: <10hPa at 40 °C
Aspect: clear	Auto ignition temperature:> 250 °C
Smell: Characteristic	Explosive properties: not considered as explosive
Flash point: > 55 °C	-

- **Decomposition**

[9] SDS heavy Zeller-fuel ULSD 1%

This substance is stable under the recommended handling and storage conditions. It reacts with acids, releasing large quantities of toxic gases. The thermal decomposition of the product can release or form phosgene (CCl_2O), chlorine (Cl_2).

- **Incompatibility / reactivity**

The conditions to avoid are cold and exposure to light. It must be kept away from acids. On contact with an acid, it gives off a toxic gas. It is also incompatible with metals (decomposition with formation of hydrogen).

- **Toxicity**

This product is irritating to the skin and can create dermatitis. Inhalation of high concentration vapors may cause irritation of the respiratory system and lead to risks of central nervous system depression with nausea, headache, dizziness, vomiting and loss of coordination.

Aspiration can cause pulmonary edema and pneumonia. The fluid can enter the lungs and cause damage (chemical pneumonia, potentially fatal).

- **Potential Health and Environmental Effects**

Prolonged or repeated contact may cause skin irritation. Vapors or mists are irritating to the mucous membranes, especially the eyes. Prolonged exposure to this product leads to risks of central nervous system depression with nausea, headache, dizziness, vomiting and loss of coordination. In case of accidental ingestion, the product can be aspirated into the lungs due to its low viscosity and cause serious pulmonary lesions in the hours that follow (medical surveillance is essential for 48 h).

XI.4.2.1.3. Physicochemical characteristics of sodium hydroxide

- **Definition**

Sodium hydroxide is a strong base which occurs as a solid at room temperature. The sodium hydroxide solution is a transparent aqueous solution.

- **Physicochemical properties**

Physical state: liquid	Melting point / freezing point: 5 - 12 °C
Color: colorless	Boiling point: 140° - 144 °C
smell: odorless	pH: 14.0 (5% solution)
Volatility in % by volume: 50 - 90	Vapor pressure: 1.5 mm Hg at 20 °C
Critical temperature: not applicable	Solubility: soluble in water

- **Decomposition**

The product is stable but can decompose and give toxic gases at high temperatures. Following prolonged exposure to heat, it may develop pressure. During thermal decomposition, it releases toxic products which may include sodium oxides.

- **Incompatibility / reactivity**

The product is not flammable but produces violent exothermic reactions with water.

- **Toxicity**

The substance is corrosive and may cause severe burns in case of contact with the skin.

- **Potential health and environmental effects**

It emits vapors that are extremely irritating to the respiratory tract and the eyes. Its toxicity is mainly associated with pH.

IX.4.2.1.4. Physicochemical characteristics of sulfuric acid

- **Definition**

The sulfuric acid of the crude formula H_2SO_4 still known as vitriol oil is a strong mineral acid obtained by chemical process. It is used in various fields including water treatment.

- **Physicochemical properties**[1110]

Physical state: liquid	pH: not defined
Color: colorless	Boiling point / range: 290 °C
Smell: odorless	Solubility in water: not defined

- **Decomposition**

The product is stable under recommended storage conditions. However, in case of fire, thermal decomposition generates corrosive vapors, toxic fumes, carbon monoxide, carbon dioxide.

- **Incompatibility / reactivity**

This product should be protected from direct sunlight and extremely high or extremely low temperatures. It must not be in contact with strong acids and strong bases.

- **Toxicity**

This product is corrosive and causes severe skin burns and eye damage.

IX.4.2.1.5. Physicochemical characteristics of sodium hypochlorite

- **Definition**

Sodium hypochlorite is a chemical compound with the crude formula NaClO. It is a very unstable white solid commonly used in aqueous solution as a disinfectant and bleaching agent. In this project's framework, it is used to treat the water necessary for the needs of the process.

- **Physicochemical properties**

Physical state: liquid	pH: not defined
Color: colorless	Boiling point / range: not applicable
Smell: typical of chlorine	Solubility in water: completely soluble

- **Decomposition**

This substance is stable under the recommended handling and storage conditions. It reacts with acids, releasing large quantities of toxic gases. The thermal decomposition of the product can release or form phosgene (CCl_2O), chlorine (Cl_2).

- **Incompatibility / reactivity**

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[11] SDS Sulfuric Acid case no.: 7664-93-9

The conditions to avoid are cold and exposure to light. It must be kept away from acids. On contact with an acid, it gives off a toxic gas. It is also incompatible with metals (decomposition with formation of hydrogen).

- **Toxicity**

This substance is harmful if swallowed. It can cause irreversible skin damage, such as visible necrosis through the epidermis and in the dermis, following an exposure of up to three minutes. Corrosive reactions are characterized by ulceration, bleeding, bloody pressure ulcers and, at the end of a 14-day observation period, by discoloration due to whitening of the skin, areas of alopecia and scars.

IX.4.2.1.6. Physicochemical characteristics of sodium chloride

- **Definition**

Sodium chloride is an ionic chemical compound with the formula NaCl. It is used within the framework of this project for the neutralization in the process of treatment of the water necessary for the needs of the process.

- **Physicochemical properties**

Physical state: crystalline solid	5 <pH <7
Color: colorless	Oxidizing properties: none
Smell: odorless	Not classified as explosive

- **Decomposition**

The material is stable under normal and foreseeable ambient conditions of storage and handling, regarding temperature and pressure. It is not combustible but in case of fire, there is a risk of release of hydrogen chloride.

- **Incompatibility / reactivity**

This material is not reactive under normal ambient conditions. Conditions to avoid are humidity. Sodium chloride is incompatible with iron and can cause exothermic reactions with lithium and alkali metals.

- **Toxicity**

This product is not classified as corrosive to the skin, nor toxic.

Table 61 : Summary of the risks related to chemical products[11]

Product	Physical state	Danger symbol / pictogram	Risk phrase R	Safety phrase S	Flammability	Toxicity	Risk statement H	Precautionary statement P
Heavy fuel oil	Viscous liquid	 **Danger to health** (may have or is presumed to have serious health effects)  **Exclamation point** (may cause less severe effects on health and ozone layer*)  **Environment** (may be harmful to the aquatic environment)	R45, R63, R20, R48/21, R38, R66, R50/53		Flammable	Harmful if inhaled Very toxic to aquatic organisms	H332, H350, H361d, H373, H410	-
Light fuel oil (diesel)	Liquid	   	R20, R38, R40, R65, R51/53		Flammable	Corrosive Acute toxicity	H226, H304, H315, H332, H351, H373, H411	P210, P261, P280, P301 + P310, P331, P403 + P233, P273, P501
Sodium hydroxide	Liquid		-	-	Non-flammable Not explosive	Corrosive	-	-

[11] Les significations des phrases de risque et mention de danger sont en annexe du document.

Product	Physical state	Danger symbol / pictogram	Risk phrase R	Safety phrase S	Flammability	Toxicity	Risk statement H	Precautionary statement P
Sulfuric acid	Liquid		R35	S26, S36/37/39 S45	No available information	Corrosive	H314, H318	P280, P260, P301/330/331, P390, P406, P501
Sodium hypochlorite	Liquid	  					H302, H314, H400	P260 P264 P270 P280 P405 P501
Sodium chloride	Crystalline solid	-	-	-	-	-	-	-

IX.4.2.2. RISKS RELATED TO USED PRODUCTS

IX.4.2.2.1. Risks of fire and explosion

The products used, in addition to their polluting nature, are combustible. Their storage and use are dangerous to the extent that they can cause thermal effects and overpressure effects following fire and explosion phenomena. Contact of an ignition source with the vapor cloud formed above the storage tank can cause the cloudy sky to explode. This is followed by overpressure effects following the rupture of the tank. However, the risk of explosion by evaporation and formation of a flammable cloud is limited to confined areas (gaseous sky of the tanks). When a hydrocarbon tank is on fire, various phenomena can occur, including the pressurization of the tank or even a boil-over phenomenon. For the record, a Boil-Over phenomenon, consecutive to a tank fire, consists of a projection of combustible liquid following the brutal vaporization of a layer of water present at the bottom of the tank. The boil-over phenomenon is caused by the viscosity of the liquid which does not allow water vapor to escape. In fact, in the event of a fire, the radiation of the flames on the surface of the liquid leads to the distillation of the liquid and separates it into two phases. The light phases rise to the surface while the heavy phases, under the effect of gravity gradually descend towards the bottom of the tank where the formation of the heat wave. This heat wave, in contact with the water at the bottom of the tank (fire extinguishing water or water of condensation) leads to an evaporation of the water which is manifested by a sudden vaporization of the heavy phases towards the outside. Part of the burning liquid flows on the ground the other turns into a fireball. The thermal flux which comes with this phenomenon is short and intense. The overpressure wave resulting from the phenomenon remains limited. The boil-over phenomenon is of very rare occurrence with a fairly long trigger time that can allow the arrival of help and the evacuation of targets.

It should be noted that the fire or explosion of a hydrocarbon tank or a pipeline is favored mainly by the presence of an ignition source or by domino effect and that a pool fire can lead to the formation of a fireball by a chronological sequence (see following image).

Image 1 : Domino effects following a hydrocarbon fire[12]

Legend: Pool fire /Explosion of the tank/Fire of the tank/Fireball/Approximately two hours after the fire in compartment/ Several hours after the explosion

The ignition source promoting fire and explosion in the presence of oxygen can come from:

- hot spot work (welding, cutting, etc.) during repair or maintenance operations;
- sparks of electrical origin or mechanical shock between two metals;

[12] GTDLI-Version 01

- electrical defect (ground fault, damaged cable, heating of an electrical cable, poorly performed connection work, etc.);
- recklessness of the smokers;
- etc.

Depending on the handling procedures, installation conditions, storage conditions, fires, explosions, or leaks may occur and spread, creating domino effects if preventive measures are not taken into account.

IX.4.2.2.2. Pollution risks

In case of an accidental spill or a lack of control of the oil slick or pollutant product formed on the ground, it is very likely that there is pollution of the natural environment (soil and water) or flow of the liquid towards the natural environment (underground water). Pollution of the environment by extinguishing water in case of fire is also an element to take into account.

IX.4.2.2.3Toxic Risks

Most chemicals are toxic by inhalation or ingestion or by simple contact with the skin. They present either chronic or acute toxicity that can have repercussions on the health of the individuals by creating in the long term:

- cancers, tumors;
- modifications of the genetic apparatus;
- damage to the fetus;
- irritation, burning of the skin, eyes;
- respiratory disorders;
- etc.

Toxic risks can also appear during a fire through the generation of smoke. This smoke is loaded with soot and CO which, inhaled, prevent normal breathing and may cause asphyxiation under certain conditions. However, the effects of toxic substances on humans are of different natures and of varying severities depending on the duration, the mode of exposure, etc.

IX.4.2.3. RISKS RELATED TO EQUIPMENT AND INSTALLATIONS

The operation of the power plant involves equipment and installations that present a risk of burns, hose projection, damage to the hearing system, crushing of the limbs, rupture of elements turning points, deterioration of all or part of the installation, minor electrical accidents, fire, explosion, accidental pollution, etc.

The installations likely to present risks as well as their associated phenomena are presented below.

IX.4.2.3.1. Risks related to the operation of engines and alternators

The operation of engines and other rotating parts is subject to the risk of projection of rotating parts, the generation of noise, the emission of hot gases, as well as electrical and members' crushing risks. These risks are studied more in detail in the analysis of the occupational risks.

IX.4.2.3.2. Risks related to the operation of compressors

Air compressors emit air under pressure and are electrical equipment. The operation of these installations involves electrical risks. The compressor is liable to explode, leading to risks of particle projection and overpressure effects, the consequences of which can be variable depending on the flow received by the target.

IX.4.2.3.3. Risks related to the operation of generator sets

The operation of generator sets can affect air quality and cause sound pollution. In fact, the combustion of fuel oil gives off smoke laden with dust, CO_2, CO and other harmful substances. Generator sets can also cause electrical risks.

IX.4.2.3.4. Risks related to the operation of the recovery boilers

Recovery boilers start with fuel oil and use hot gases from the generator sets. They can cause burns in addition to the risk of explosion or tube breakage.

IX.4.2.3.5. Risks related to the operation of the transformer

An overvoltage or overcurrent in the transformer station can cause electrical risks.

These accidents can lead to the deterioration of the installation and a rupture of the oil tank, thus causing pollution of the environment. An electrical failure on the transformer can cause a fire or an explosion.

IX.4.2.3.6. Risks related to refueling, unloading and storage of dangerous products

The delivery, unloading and storage of fuel oil can create the risk of fire, explosion or pollution. In fact, these risks are due to:

- traffic accidents during refueling;
- accidental oil spills during unloading;
- poor storage conditions;
- static electricity, presence of fire;
- human errors.

The transport of hazardous materials by road involves a risk that is very difficult to grasp in terms of location, identification and quantification. This risk is diffuse because it is spread over the entire trajectory of the convoy. This risk is collective because the entire population is exposed to it. Depending on routes, traffic density, targets vary and cannot be quantified.

IX.4.2.4. RISKS RELATED TO THE LACK OF UTILITY

A loss of compressed air can lead to a defect in the regulating devices and a shutdown of the machines.

A loss of engine cooling water will cause the engine temperature to rise, which leads to engine heating and seizure. The lack of water for the fire system can be catastrophic in case of a fire.

IX.4.2.5. RISKS RELATED TO OPERATIONS AND WORKING CONDITIONS

The risk assessment related to operations and working conditions in the power plant concerns all activities likely to be dangerous or to cause damage to equipment, people and the environment. These activities are developed below.

- **Risks related to internal traffic**

The circulation of the vehicles of the staff, pedestrians, supply trucks are likely to create accidents resulting in collisions between cars or between cars and materials or in bumping into people. This damage would be attributable to a poor organization concerning the directions of circulation, the planning of working hours for each specific task. This would result in injury, product spillage and property loss.

- **Risks related to physical activity**

Physical activities resulting from manual handling, repetitive movements at high speed, restrictive postures, uncomfortable positions can lead to accidents at work and, in the long run, to occupational diseases.

- **Risks related to mechanical handling**

Mechanical handling is just as dangerous because it is likely to cause accidents resulting in bumping into, collisions or falling objects. Operators are also exposed to the risk of occupational diseases because of repetitive gestures and the long posture which is sometimes restrictive.

- **Risks related to noise**

In addition to generating polluting fumes, the operation of generator sets and associated equipment generates noise. Prolonged exposure to noise and depending on the intensity received can create hearing problems in addition to causing discomfort for workers and homes around the site.

- **Health risks**

The presence and handling of heavy fuel oil poses significant toxic risks to the health of workers and populations.

In fact, the combustion of fuel oil through the operation of generator sets results in the release of polluting fumes. This smoke is all the more harmful that the sulfur contained in the fuel oil is high. At the same time, the storage of hydrocarbons as well as their spillage on the ground result risks of pollution of the soil, runoff water, groundwater, etc.

The combustion of fuel oil leads to the formation of CO, SO_2, NOx, POP, VOC. These particles, mixed with the surrounding air around the power plant, make it a polluted fluid which, inhaled, can have serious consequences on the health of the individual. These health risks result in cardiovascular diseases, asthma, respiratory diseases, allergies, cancers, etc.

IX.4.2.6. RISKS RELATED TO THE GENERATED WASTE

The contaminated waste generated is a source of pollution. They can cause soil or water pollution if not properly managed.

IX.4.2.7. RISKS RELATED TO THE ORGANIZATION OF WORK

An anarchic organization or the absence of job descriptions could be the cause of many disasters. In fact, a plethora or defective workforce in risk areas or the use of unqualified staff could lead to shortcomings or discomfort in work. This will favor a lack of concentration or submergence by the effect of fatigue and when handling sensitive or dangerous products it is very likely that accidents will occur.

Poorly organized work is also manifested in non-compliance with shift hours; which leads to job abandonment or fatigue for the on-call staff, thus reducing their vigilance. The present danger is fatigue, the associated risk depends on the parameters handled also on the sensitivity of the workstation and the products handled.

If, however, the rotation of workers is not ensured with flexible hours, these situations will lead to occupational stress which is an occupational disease with multiple consequences. This will cause errors in procedures, handling, loss of yield and even disasters.

IX.4.3. VULNERABLE ELEMENTS

After the phases of description and identification of the external and internal site risks, the environmental components most exposed to risks are the staff on site, the populations and the farmers around. The site is near populated villages. The environmental components encountered along the road by fuel oil transport trucks are also vulnerable elements to take into account.

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IX.5. ACCIDENT AND FEEDBACK

Feedback on technological accidents provides information on the various accidents that have occurred in the various sectors of activity. The challenges of feedback are clearly to make available to those who are responsible for risk prevention, information and elements of assessment drawn from real cases[1413]. The circumstances of the accident, the origin, the consequences and the follow-up given to the accidents are listed.

The use of this data makes it possible to anticipate the risks linked to the operation of the thermal power plant and helps to propose the best proactive and preventive solutions to avoid their appearance.

IX.5.1. METHODOLOGY

Research on the Accident concerning this project to install an oil-fired thermal power plant in Malicounda is drawn from the ARIA database of the Bureau of Analysis of Risks and Industrial Pollution (BARPI), attached to the Industrial Environment Department of the Ministry of Ecology and Sustainable Development of France (cf. http://aria.developpement-durable.gouv.fr). The ARIA database is today a "knowledge assets" rich with 20 000 industrial accidents recorded since 1992. The recording rate is currently more than 2000 accidents per year.[1514]The search criteria are based on activities D35.11 (electricity production), D35.30 (Production and distribution of steam and air conditioning), D35.1 (Production, transport and distribution of electricity). Details of the selected accidents are given in the annex of this document. At the national level, it was difficult to find data on Accident. However, throughout the news, a few cases have been identified which have been taken into account in the preliminary risk analysis.

IX.5.2. ACCIDENT RESULTS

XI.5.2.1 TYPES OF ACCIDENTS IDENTIFIED

Oil-related accidents are the most prevalent. Oil spills, fire outbreaks, fires and even explosions have been reported. A tank fire had to lead to a boil-over phenomenon. The following figure illustrates the types of accidents

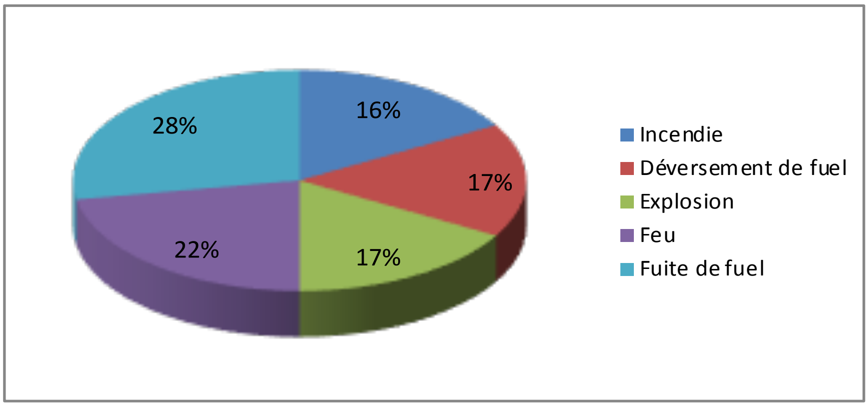

Figure 21: Types of accidents identified

Legend: Fire conflagration/ Fuel spills/Explosion/Fire/Fuel leak

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[14] http://www.impel.eu/wp-content/uploads/2016/06/2001-03-accidents-FINAL-REPORT-fr.pdf page consultée le 23/08/2017

[15] http://www.impel.eu/wp-content/uploads/2016/06/2001-03-accidents-FINAL-REPORT-fr.pdf page consultée le 23/08/2017

IX.5.2.2. CAUSES OF ACCIDENTS

Accidents in oil-fired power plants are generally due to two factors:

human intervention;

material defects.

The causes due to the human factor reach a proportion of 31% and are related to work by hot spots, operational errors such as poorly closed valves, or lack of maintenance. This last point is one of the causes of equipment failure that reaches 53% of the causes of accidents. However, there are still accidents with unknown causes. The following figure provides information on the various causes of the accidents listed.

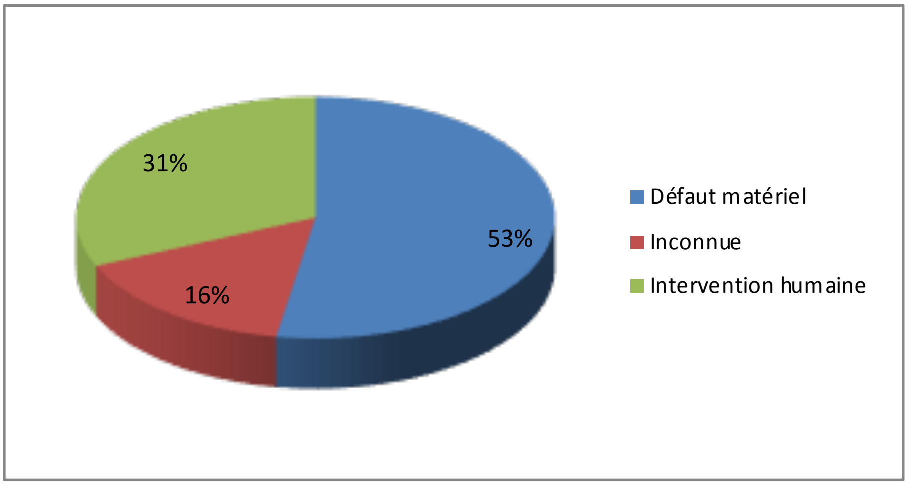

Figure 22 : Causes of accidents

Legend: Mmaterial defect/ Unknown/ Human intervention

IX.5.2.3. INVOLVED EQUIPMENTS

The fuel oil circuit (28%), the fuel oil tanks (28%) and the steam generators (22%) are the most recurrent equipment that are involved in the occurrence of accidents, the other elements of the power plant rarely intervene. The following figure shows the proportion of the various equipment involved in the accidents.

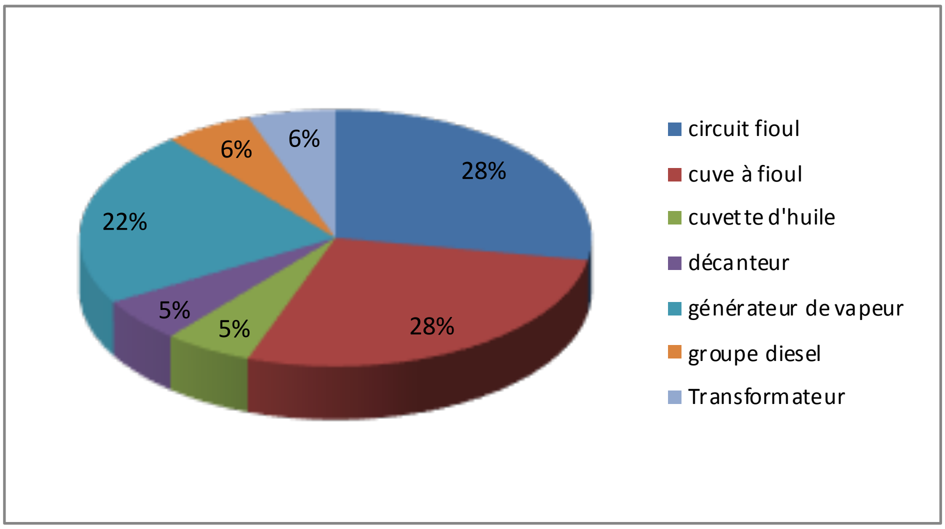

Figure 23 : Equipment implicated in accidents

Legend: Fuel circuit/Fuel tank/Oil sump/Decanter/Steam generator/Diesel generator/Convertor

IX.5.2.4. CONSEQUENCES OF ACCIDENTS

The most feared consequences of these accidents are the loss of life and serious injuries, which reach a proportion of 28%. The dangerous phenomenon involved is the explosion of a steam generator, generally due to a fault in the equipment.

The fuel tank fire that caused the oil burnout also killed hundreds of people and seriously injured them.

Pollution of surface water, groundwater and soil pollution are the main environmental consequences of accidents linked to fuel oil (spillage during filling of oil tanks, and leak in fuel oil circuits). These attacks on the physical components of the environment have a proportion of 33%.

The following figure shows the consequences with their percentage. However, rapid intervention when an accident occurs has limited damage, which explains the 28% of accident cases that are without damage.

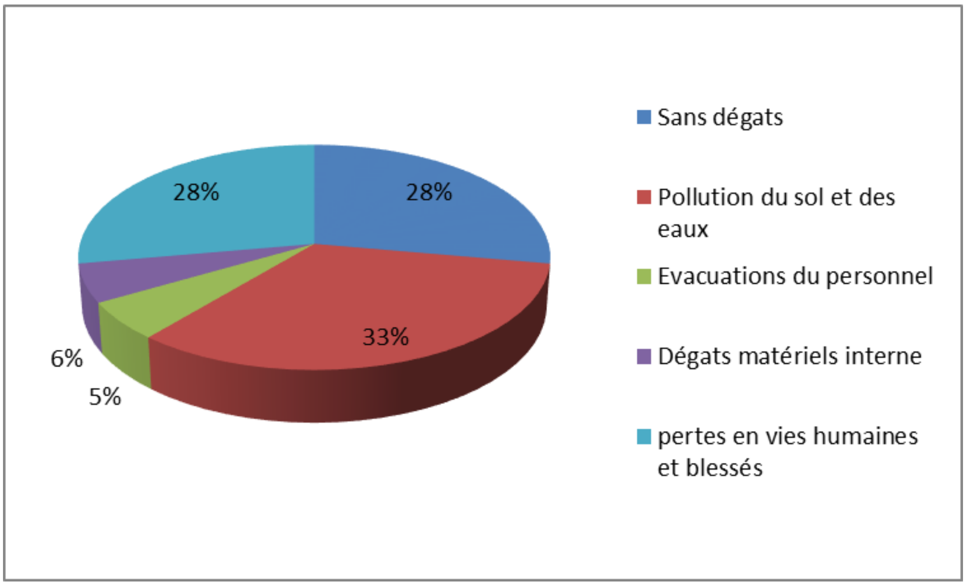

Figure 24 : Consequences of accidents

Legend: Without damage/Soil and water pollution/Evacuation of personnel/Internal material damage/Loss of life and injuries

IX.5.3. ACCIDENT SUMMARY

Feedback allows us to focus in particular on accidents related to fuel oil (during the unloading / transfer of fuel oil or filling of storage tanks), and accidents related to boilers. The consequences of these accidents are very often the pollution of the receiving environment, material damage, injuries and loss of human life.

The lessons learned from this Accident are:

- to maintain the proper functioning of the equipment by regular inspection in order to avoid their failure;
- to ensure proper training and awareness of operating staff;
- to put in place a good fuel oil monitoring device at all levels of the power plant;
- to provide workers with training on risk prevention;
- to put in place means of prevention, protection and intervention in the event of an accident or incident.

IX.6. PRELIMINARY RISK ANALYSIS

Risk can be defined as the possibility of damage occurring following an exposure to the effects of a dangerous phenomenon. In fact, it is the cross between the probability of the occurrence of a dangerous phenomenon and the severity of its induced effects.

The preceding actions risk analysis amounts to quantifying all the causes and consequences of the dangerous phenomena feared in the installation or which could come from its equipment. Thus, it makes it possible to list the various risks and to classify them according to a flat-rate hierarchy through a rating scale; which then makes it possible to define the different risk categories as indicated in the Senegal risk study guide.

Its arguments are based on the identification of potential risks, on Accident and on the issues. As a result, the APR allows to classify the risk according to a rating scale and at the same time prioritizes them according to their degree of criticality defined by the color assigned to them.

It allows to confirm or deny the existence of a major risk, therefore, the feasibility or not of a detailed risk study. At the same time, the APR allows to release means of prevention against feared events and means of protection against the effects of probable dangerous phenomena.

Following the results of the APR only the most significant dreaded events will be analyzed in detail. The latter provide information on the most likely dangerous phenomena to occur in installations or received by them.

For each component of the project, it is a question of identifying:

- the feared events;
- the resulting dangerous phenomena;
- their causes, the preventive measures planned by the project and supplemented by the consultant;
- the consequences, the control measures planned by the project and completed by the consultant.

IX.6.1. METHODOLOGY

IX.6.1.1. ESTIMATION OF THE RISK LEVEL

The estimation of the level of risk amounts to making a rating on the basis of which the risks will be prioritized. The installation must first be divided into systems to better understand the likely risks. The estimation is done according to several methods.

Preceding actions risk analysis is the method used in this risk study concerning the installation of a power plant.

The results of the APR allow to identify the feared events, the induced dangerous phenomena as well as the harmful effects that they can cause.

Thus, depending on the severity of the effects and their probability of occurrence, they will be assigned lump sum values which will be entered in a grid in accordance with the Senegal risk study guide. The allocation of these scores also depends on the information obtained through feedback from similar accidents that have taken place in other facilities.

Table 62: Matrix of risk allocation[15]

Probability scale (P)		Severity scale (G)	
Score	Meaning	Score	Meaning
1 = improbable	Never seen in this industrial sector; -Almost impossible in the establishment	**1 = negligible**	-Minimal impact on the staff -No operational shutdown -Low effects on the environment
2 = rare	-Already encountered in this industrial sector; -Possible in the establishment	**2 = minor**	-Medical care for the staff -Minimal damage -Little loss of products -Minimal effects on the environment
3 = occasional	-Already seen in the establishment; -Occasional but can happen sometimes in the establishment	**3 = important**	-Seriously injured staff (extended work cessation) -Limited damage -Partial exploitation cessation - signifiant environnemental effets
4 = frequent	-Happens two to three times in the establishment	**4 = critical**	-Disabling injury for life, (1 to 3 deaths) - Significant damage - Partial cessation of operations -significant environmental effects
5 = constant -	-Occurs several times a year in the establishment (greater than 3 times a year)	**5 = catastrophic**	- Several deaths - Very extensive damage -Long production cessation

The combination of the two scores assigned to each risk factor allows to rate it as a tolerable, significant or unacceptable risk depending on the color code which it will be assigned to it through the following table.

Table 63 : Matrix of risk quotation[16]

Level of Risk		**Consequences**				
		5	**4**	**3**	**2**	**1**
Probability	**5**					
	4					
	3					
	2					
	1					

By crossing the probability and severity, the risk incurred will be on one of the three levels represented by the following colors:

- **Green**: **tolerable risk**. According to the Senegal risk study guide, no action is required.
- **Yellow**: **significant risk**. According to the guide, a short, medium- and long-term reduction plan must be implemented.
- **Red**: **high risk, unacceptable**. Any risk contained in this red part is considered to be major and therefore, in accordance with the guide, a detailed study including the development of scenarios of accidents that may lead to it is required. As a result, prevention and protection measures must be put in place immediately in order to reduce and control the risk.

[15] Source : Guide d’étude de dangers du Sénégal

[16] Source : Guide d’étude de dangers du Sénégal

IX.6.1. DIVISION INTO SYSTEM

In order to better understand the risks, especially the major risks induced by the various components of the site, the power plant is subdivided into different systems reflecting the different activities inside. These systems are as follows:

System 1: oil unloading and hydrocarbon storage areas;

System 2: recovery boilers;

System 3: diesel groups;

System 4: transformer;

System 5: demineralization station and effluent treatment system;

System 6: circulation and fuel supply.

IX.6.2. PRESENTATION OF THE RESULTS

The results of the APR are shown in the table below. The feared events identified were analyzed in order to know their causes and consequences. Preventive measures directed against these dangerous events have been proposed; also means of mastering the consequences.

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Table 64 : Preliminary risk analysis

Sources of ignition			
Dreaded event	**Cause**	**Consequence**	**Prevention**
High temperature	Work by hot spot Mechanical or electrical heating	Start of a fire Fire Formation of explosive clouds Explosion	Temperature sensors in the hot parts of rotating equipment Automation generating alarms and/or safety action in case of overheating Issuance of a work permit or fire permit for each maintenance intervention requiring the use of tools or equipment likely to cause sparks or flames (blowpipe, hacksaws, etc.) Grounding of the circuit Preventive inspection and maintenance of equipment Firewall Preventive extinction of fires (of brush) Lightning protection Guarding Fenced site, regulated access, identified external parties
Flame / Sparks	Mechanical shock causing sparks Short electric circuit Lightning Maliciousness		

System 1: Hydrocarbon stripping and storage areas											
N°	**Dreaded event**	**Causes**	**Consequences**	**Pi**	**Gi**	**Ri**	**Preventive measures**	**Measures to control the consequences**	**Pf**	**Gf**	**Rf**

1.1	Hydrocarbon leak at the truck unloading station	Defective unloading hose Overfilling of trucks Disconnection of the unloading hose on the pump side or on the truck side Non-compliance with operating conditions	Product spilling Soil pollution Fire / explosion if an ignition source is present Possibility of domino effect in case of fire	**3**	**4**		Preventive maintenance and inspection Strict application of the unloading procedures including braking and stalling of the vehicle Equipotential bonding of the trucks and the unloading system Continuous monitoring of the unloading operations	Fuel oil recovery drain Transfer pump emergency stop system Existing operation procedure Well-dimensioned fire network, FHC, appropriate fire extinguishers in place Permanent presence of the operator during the unloading Existing IOP Intervention of the firefighters	**2**	**3**	
1.2	Leak of hydrocarbon on the fuel storage / transfer line	Non-compliance with operating conditions Corrosion, overpressure Crack caused by failure in the pipeline Defective valves or flanges	Spreading of the product with risk of pollution Fire / explosion in the presence of an ignition source	**2**	**4**		Preventive maintenance and inspections Regular checks by visual inspection Compliance with the instructions in the operating manual Training of line operators	System monitoring Emergency stop of the fuel transfer pump Product recovery drain Pump stop on low / high pressure Fire-fighting means provided in sufficient quantity (meshed fire network, cooling rings, wheeled fire extinguishers, …)	**2**	**3**	

								Security service and first aid team members Existing IOP			
1.3	Leak or overfilling of the tank	Non-compliance with operating conditions Inadvertent errors Loss of containment of the tank (impact of projectile, corrosion, etc.)	Spreading of product and risk of pollution Fire / explosion if an ignition source is present Possibility of domino effect in case of fire	**2**	**4**		Level sensor in fuel oil storage tanks Flow control loop Preventive inspection and maintenance of equipment Periodic tank verification by qualified staff Keep a safety register	Well-sized retention basin in the wall connected to a hydrocarbon separator Well-paved and waterproof surface Well-sized fire network, FHC, Cooling fire rings Appropriate extinguishers in place Easy access for firefighters Operator round Existing IOP	**2**	**3**	
1.4	Loss of physical integrity of a fixed roof tank following an internal overpressure	Increase of the temperature of the liquid High temperature that can modify the	Overpressure followed by a shock wave Loss of containment of the tank	**2**	**5**		Vent in the atmosphere (not isolable) Protection of the coat by an adequate coating	Monitoring system Well-sized retention basin in the wall connected to a hydrocarbon separator;	**2**	**3**	

		conditions inside the tank Non-compliance with operating conditions	Scattering of fragments Spreading of the liquid and possibility of a fire bowl if an ignition source is present Emissions of toxic smoke Thermal effects and possibility of a boil-over				Preventive maintenance and inspections of the tanks and related equipment by qualified staff Blanketing with nitrogen in case of long-term non-use Regular visits to the inhalation valves Training of the staff involved and maintenance instructions Staff training	Well-paved and waterproof surface. Fire-fighting means (meshed fire network, cooling rings, wheeled fire extinguishers, etc.). Flame arresting device on the air vent. Safety service and first aid team members. Existing IOP			
1.5	Loss of containment of a tank	Corrosion Shock by vehicle collision, projectile Operating error Faulty valve at the bottom of the tank Corrosion, mechanical damage due to interventions	Spreading of fuel with risk of pollution Possibility of a bowl fire in the presence of an ignition source with emission of toxic smoke Spreading of thermal radiation and possibility of fire	**3**	**4**		Visual monitoring and by means of leak detectors Installation of reliable fuel level indicators on the fuel oil tanks (heavy, light) Preventive maintenance and	Well-sized retention basin in the wall connected to a hydrocarbon separator; Well-paved and waterproof surface Well sized fire network, FHC, Cooling fire rings Appropriate extinguishers in places,	**2**	**3**	

		on the tank or extreme weather conditions Accidental opening of a drain valve	from nearby tanks, followed by a boil-over Emissions of toxic smoke				inspection of the tanks and related equipment Blanketing with nitrogen in case of long-term non-use Regular visits to the inhalation valves Access prohibited to any stranger to the power plant by beaconing and information Restricted access to the storage area Training of staff involved and maintenance instructions	Easy access to firefighters Regular control of the water level at the bottom of the tank and purge as soon as the water height is high Regular tests of the fire network Operator round Existing IOP			
1.6	Presence of flammable vapors in the gaseous sky of the storage tank and sufficient energy to initiate an explosion	Work by hot spot Electric sparks Lightning Spread of a fire	Explosion of the gas phase of the tank followed by a fire Emission of shock waves and heat flow Spill and jet of flaming hydrocarbon Risk of fire spread Injury	**2**	**5**		Tank degassing and atmosphere control prior to any activity Grounding of installations Staff empowerment Fire permit during hot spot operation Staff training	Presence of first aid care Direct line with firefighters Presence of a team of first aiders on site Staff awareness on the risks of the profession	**2**	**4**	

N°	Dreaded event	Causes	Consequences	Pi	Gi	Ri	Preventive measures	Measures to control the consequences	Pf	Gf	Rf
			Material damage				Staff awareness				
System 2: Recovery boilers											
N°	**Dreaded event**	**Causes**	**Consequences**	**Pi**	**Gi**	**Ri**	**Preventive measures**	**Measures to control the consequences**	**Pf**	**Gf**	**Rf**
2.1	Break in the HP steam supply line to the turbine	Very high temperature and pressure Corrosion Mechanical damage Shock Projectile Failure to regulate	Loss of containment of vapor collector with HP steam emission Risk of severe burns Overpressure Missile projection	**2**	**4**		Temperature and pressure sensors Preventive inspection and maintenance of equipment, regular control of water from the PDD Limited access Prohibited handling nearby Staff training	System control Immediate shutdown of the boiler Limited and regulated access in case of combined cycle operation Operator round Existing IOP	**2**	**3**	
System 3: Diesel groups											
N°	**Dreaded event**	**Causes**	**Consequences**	**Pi**	**Gi**	**Ri**	**Preventive measures**	**Measures to control the consequences**	**Pf**	**Gf**	**Rf**

3.1	Loss of containment of oil tanks	High temperature that can modify the structure of the tank Corrosion shock, projectile Non-compliance with the operating conditions	leakage of lubricating oil localized Pollution fire / explosion in the presence of an ignition source	**3**	**2**		Temperature and pressure indicator with alarm Oil cooler at the inlet from the tank Adapted construction materials Adapted and well-sized retention Preventive maintenance and inspection Staff training	System monitoring by DCS Leak detection by detecting the oil level in the tank Drainage to a hydrocarbon separator Well-paved and waterproof surface Well-sized fire network, FHC Operator round Existing IOP	**2**	**2**	
3.2	Oil filling or overfilling	Transfer of too much product Unintentional error	Oil spreading and risk of localized pollution Fire / explosion in the presence of an ignition source	**2**	**3**		Level sensor in the crankcases Flow control loop Preventive inspection and maintenance of equipment Oil retention Operating round	System monitoring by DCS Leak detection by detection of the oil level in the tank Drainage to a hydrocarbon separator Well-paved and waterproof surface	**2**	**2**	

								Well-dimensioned fire network, FHC Operator round Existing IOP			
3.3	Presence of unburnt fuel in the combustion chamber after flame extinction	Failure during fuel supply in the combustion chambers Air defect in the combustion chambers	Fire / explosion Loss of the installation integrity	**2**	**4**		Preventive maintenance and inspection Permanent control of combustion parameters (flame, temperature, air flow, etc.) Strict operation procedure Control of the air supply in the combustion chambers Staff training	System monitoring Automatic closing device "**flow dividers**" Well-sized fire network, FHC, Appropriate extinguishers in places Limited access Existing IOP	**2**	**3**	
System 4: Transformer											
N°	**Dreaded event**	**Causes**	**Consequences**	**Pi**	**Gi**	**Ri**	**Preventive measures**	**Measures to control the consequences**	**Pf**	**Gf**	**Rf**
4.1	Short circuit on the transformer	Heating of the conductors	Fire / explosion Material loss	**2**	**4**		Regular control of the protections at each departure	Automatic electrical isolation device of the	**2**	**3**	

		Corrosion of the conductors Presence of humidity Maintenance defect					Preventive inspection and maintenance of the equipment Lightning protection Grounding Training and awareness of the staff operating there	transformer in case of malfunctioning Well-sized fire network, FHC, Appropriate fire extinguishers in place Operator round Presence of first intervention team existing IOP			
4.2	Loss of containment of oil storage	Corrosion Mechanical damage External heat source Impact of projectile	Oil spreading and risk of localized pollution Fire / explosion in the presence of an ignition source	**2**	**3**		Preventive inspection and maintenance of equipment Oil level indicator Limited access	System monitoring Automatic leak detection Oil drainage to a hydrocarbon separator Immediate shutdown of the turbo generator group in case of a major leak, and isolation of the transformer	**2**	**2**	

								Well-sized fire network, FHC, Appropriate fire extinguishers in place Operator round Presence of first intervention team Existing IOP			
System 5: Demineralization station and effluent treatment system											
N°	**Dreaded event**	**Causes**	**Consequences**	**Pi**	**Gi**	**Ri**	**Preventive measures**	**Measures of control of consequences**	**Pf**	**Gf**	**Rf**
5.1	Loss of confinement of a demineralization cell	Corrosion Projectile shock	Pollution Skin contact with the operator	**3**	**3**		Adapted and proven construction materials for the regeneration phases Preventive inspection and maintenance of equipment No handling near the demineralization area Training and empowerment of staff operating there	System monitoring Retention basin Procedure for handling chemicals Operational procedure for carrying out the regeneration of demineralization cells Operator round	**2**	**2**	
5.2	Overflow of the effluent treatment unit	Corrosion Operating error	Leak emulsion / contaminated liquid	**2**	**3**		Preventive inspection and	System monitoring	**2**	**2**	

N°	Dreaded event	Causes	Consequences	Pi	Gi	Ri	Preventive measures	Measures to control the consequences	Pf	Gf	Rf
	(emulsion, oil, diesel, fuel oil etc.)	Fall-back operation	soil pollution				maintenance of equipment level sensors tanks Compliance with operating instructions	Automatic leak / overflow detection Immediate stop of the transfer pump to another decantation point Construction of secondary pits connected to the main skimmer Construction of a buffer pit between the skimmer and the final outlet Regular emptying			
System 6: Circulation and fuel supply											
N°	**Dreaded event**	**Causes**	**Consequences**	**Pi**	**Gi**	**Ri**	**Preventive measures**	**Measures to control the consequences**	**Pf**	**Gf**	**Rf**
6.1	Accident	Human error Mechanical failure	Hydrocarbon spill and soil pollution Fire in the hydrocarbon slick on the ground Possibility of domino effect	**2**	**3**		Staff training Awareness of transporters Daily review of tank trucks Well-defined delivery circuit Establish an internal circulation plan Display danger pictograms on trucks	Activation the IOP Call for emergency assistance	**2**	**2**	

							Obtain the SDS of the transported products Equip trucks with firefighting equipment				

IX.6.3. SUMMARY OF RISK ANALYSIS

The preliminary risk analysis made previously allows to present all the systems on the criticality matrix. Each system is represented by its corresponding number.

The table below is a summary of the risk levels of the dreaded events identified.

Only the final risks have been taken into account.

Table 65 : Summary of the risk level of the dreaded identified events

		SEVERITY				
		5	**4**	**3**	**2**	**1**
PROBABILITY	**5**					
	4					
	3					
	2		1.6;	1.1; 1.2; 1.3; 1.4; 1.5; 3.3; 2.1; 4.1;	2.1; 3.1; 3.2; 4.2; 5.1; 5.2; 6.1;	
	1					

The criticality grid does not reveal dreaded events deemed unacceptable, however, five events deemed important were drawn from the preceding actions risk analysis. These are:

- 1.1: Hydrocarbon leak at the truck unloading station
- 1.2: Hydrocarbon leak on the fuel storage / transfer line
- 1.3: Leak or overfilling of the hydrocarbon tank
- 1.4: Loss of physical integrity of a fixed roof tank following an internal overpressure
- 1.5: Loss of containment of the hydrocarbon tank
- 1.6: Presence of flammable vapors in the gaseous sky of the storage tank and sufficient energy to initiate an explosion
- 2.1: Rupture HP steam supply line to turbine
- 3.3: Presence of unburnt fuel in the combustion chamber after flame extinction
- 4.1: Short-circuit on the transformer

Despite the absence of events deemed unacceptable, certain aspects deserve a detailed analysis to highlight their likely effects on the targets and thus propose effective prevention and protection barriers

Table 66 : Accident scenarios to be modeled

Number	Scenario	Reference of the dreaded event
Scenario 1	Explosion of the gaseous ceiling of a hydrocarbon tank	1.4; 1.6
Scenario 2	Retention bowl fire	1.1; 1.2; 1.3
Scenario 3	Bin fire	1.3
Scenario 4	Thin layer boil-over of the light fuel oil storage tank	1.4; 1.5
Scenario 5	Classic boil-over of a heavy fuel oil storage tank	1.4; 1.5
Scenario 6	Transformer explosion	3.3; 4.1
Scenario 7	Steam boiler bursting	2.1

IX.7. DETAILED RISK ANALYSIS

Following the results of the Accident and the conclusions of the preceding actions risk analysis, simulations were carried out on certain identified scenarios that are likely to occur inside the power plant. Thus, the thermal effects and the overpressure effects associated with each type of accident were identified for the purpose of:

- estimating the effect distances and characterizing the intensity of the effects associated with each studied scenario. The necessary modeling will be done using appropriate software and calculation means developed in reference manuals (INERIS, GTDLI) and will not take into consideration the preventive measures planned to ensure site and neighborhood security;
- studying all the possibilities for reducing major risks by identifying all the dangerous phenomena whose effects are likely to spread outside the factory;
- identifying all the environmental and social issues appearing in the critical areas detected through modeling and proposing actions to control the consequences.

Only the physical phenomena will be evaluated, and for each of them the effect distances at the regulatory thresholds will be given.

The potential targets of the damage caused by these events are human beings, property and natural environment.

IX.7.1. REGULATORY EFFECTS THRESHOLD

IX.7.1.1. THERMAL EFFECTS THRESHOLD

The thermal flux phenomenon most often appears in case of a fire. When the duration of the phenomenon is greater than or less than two (02) minutes (tank lights, pool fire, UVCE (Unconfined Vapor Cloud Explosion), BLEVE (Boiling Liquid Expanding Vapor Explosion), etc.), the calculation of the effects distances gives values expressed in **kW / m^2** or **(kW / m2)$^{4/3}$·s**

The reference threshold values for men and structures are described in the following table

.

Table 67 : Thermal effects thresholds

REFERENCE VALUE		EFFECTS ON HUMAN
Phenomenon ≥ 2 mn Heat flux (kW / m2)	**Phenomenon ≤ 2 mn Thermal Doses [kW / m2] 4 / 3.s**	
3	600	Irreversible effects threshold, blisters in 30 s for unprotected persons
5	1000	First lethal effects threshold
8	1800	Significant lethal effects threshold delimiting the area of very serious dangers for human life
REFERENCE VALUE (kW / m2)		**EFFECTS ON STRUCTURES**
5		Glass destruction threshold by thermal effect
8		Threshold for domino effects and corresponding to the threshold for serious damage to structures;
10		Domino effects Risk of ignition for combustible materials

IX.7.1.2. OVERPRESSURE EFFECTS THRESHOLD

Overpressure is considered to be the consequence of an explosion, manifested by the spread from the explosion area of a pressure wave in the atmosphere. It is expressed in **hPa** or in **mbar**.

The reference values as well as the effects on humans and structures are set out in the table below.

TABLE 68 : OVERPRESSURE EFFECTS THRESHOLD

Reference value (mbar)	Effects on humans	Effects on structures
20	Irreversible effects threshold corresponding to the area of indirect effects on humans	Glasses destruction threshold greater than 10%
50	Irreversible effects threshold corresponding to the area of significant danger for humans	Slight damage to structures threshold, destruction of 75% of the glasses
140	First lethal effects threshold	Domino effects threshold Partial collapse of walls and roofs of houses
200	Significant lethal effects threshold delimiting the area of very serious dangers for human life	Domino effects threshold

IX.7.2. PRESENTATION OF CALCULATION TOOLS

The values of the heat fluxes generated by fires were modeled using a calculation tool developed by INERIS and taking into account the GT-DLI method.

The tool used to calculate the bowl fire and the tank fire, is a simplified version of the FNAP model described in the Omega 2 report regarding pool fires.

These calculation tools can be consulted on the Integrated Resource Platform for the control of major risks.

The overpressure effects related to a bursting of a fixed roof bin will be calculated according to the extracts from the note of the GT-DLI.

The transformer explosion was modeled using a spreadsheet based on the PROJEX method developed by INERIS.

The different stages of the calculation are presented in annex 6 of the report.

IX.7.3. MODELING OF ACCIDENTS SCENARIOS

The scenarios concerning the hydrocarbon deposits are made on a:

- permanent storage tank of 3000 m^3 of heavy fuel oil;
- daily tank of 560 m^3 of heavy fuel oil;
- buffer tank of 560 m^3 of heavy fuel oil;
- storage tank of 200 m^3 of light fuel oil.

IX.7.3.1. SCENARIO 1: EXPLOSION OF THE GASEOUS CEILING OF THE TANK

IX.7.3.1.1. Description of the accident

A fire in the retention basin of the tank causes the heating of the hydrocarbon tank. Following an increase in temperature in the fuel oil storage tank, the pressure also increased and an explosion of the tank followed. This scenario is modeled for the permanent fuel oil tank, the daily fuel oil tank as well as for the light fuel oil tank because it is possible that such an accident could occur on one of these storage tanks. Only overpressure effects have been studied.

IX.7.3.1.2. Methodology for the evaluation of the effect distances

The evaluation of the distances of effects of the shock wave following an explosion of an atmospheric tank with a fixed roof was carried out using the calculation method developed by the GT -DLI. This relatively simple method consists in assimilating the explosion of a gas cloud to the explosion of a mass of TNT (See annex 6.1).

IX.7.3.1.3. Input parameters

The basic data necessary to make the calculations for each type of product or quantity involved are listed in the following table.

Table 69 : Input parameters-scenario 1

Model	Tank volume	Tank diameter	Tank height
Permanent heavy oil storage tank	3000 m^3	16 m	16 m
HFO buffer tank	560 m^3	10.91	6
HFO daily tank	560 m^3	10.91	6
Storage tank of 200 m^3 of light fuel oil	200 m^3	7.99 m	4 m

IX.7.3.1.4. Modeling results

The results of the modeling of the explosion of the gaseous ceiling of the various fuel oil storage tanks are listed in the table below.

Table 70 : Scenario 1 modeling results

Threshold values of the overpressure waves		50 mbar	140 mbar	200 mbar
Distances of the overpressure effects of the various tanks	Permanent storage tank of 3000 m^3 of heavy fuel oil	76 m	35 m	26 m
	Daily tank of 560 m^3 of heavy fuel oil	43 m	20 m	15 m
	Buffer tank of 560 m^3 of heavy fuel oil	43 m	20 m	15 m
	Storage tank of 200 m^3 of light fuel oil	31 m	14 m	11 m

IX.7.3.1.5. Interpretation of results

In view of the modeling results from the explosion of the gaseous ceiling of the various hydrocarbon storage tanks, it is noted that the effect distances of the overpressure wave obtained for each model will not go beyond the limits of the site.

However, there are possibilities of accident synergy since certain installations can be affected by the effects of such accident.

Therefore, it is necessary to degas the tanks and control the atmosphere before any operation on the tanks. The grounding of the tanks as well as the empowerment and awareness of the staff in charge of handling the tanks are essential in order to avoid any procedural error. The fire permit during hot spot operation must be a requirement of any agent having to intervene on or near the fuel or other flammable products storage areas.

IX.7.3.2. SCENARIO 2: RETENTION BOWL FIRE

IX.7.3.2.1. Description of the accident

A corrosion of the fuel oil storage tank or failure of a valve flange resulted in a leakage and spillage of the liquid over the entire surface of the retention.

Following the spread of a fire, the oil slick ignites and emits thermal radiation.

This scenario is modeled for the various hydrocarbon storages and the distances of the thermal effects associated with this accident have been studied.

IX.7.3.2.2. Effects distances evaluation methodology

The intensity of the thermal effects of this bowl fire was evaluated using the PRIMARISK tool, that is based on the principles developed by INERIS arising from the model called "GT-DLI model" stated in the French circular no DPPR / SEI2 / AL-06-357 of January 31st 2007 related to the studies of dangers of deposits of flammable liquids. (See annex 6.2).

IX.7.3.2.3. Input parameters

The fuel oil and LFO permanent storage tanks are on the same retention, in addition, the HFO buffer tank as well as the daily HFO tank are on the same retention; thus, the bowl fire scenario will be achieved using the largest volumes of storage in the two retentions.

The basic data necessary to make the calculations for each type of product or quantity involved are listed in the following table.

Table 71 : Input parameters-Scenario 2

Tank Type	Bowl length	Bowl width	Bowl height	Fire shape
Permanent storage tank of 3000 m^3 of heavy fuel oil	85 m	35 m	1.6 m	Rectangular
Daily tank of 560 m^3 of heavy fuel oil	33 m	22 m	2 m	Rectangular

The environmental conditions used to make the calculations are the following:

- Room temperature: 25 °C
- Wind speed: 2.7 m/s

- Relative humidity: 0.84

IX.7.3.2.4. Modeling results

The characteristics of the flame obtained after modeling are as follows.

Table 72 : Characteristics of the flame

Model	Calculated flame length	Calculated flame inclination	Calculated flame height
Retention tank of the permanent storage tank of 3000 m^3 of fuel oil	46 m	12 °	45 m
Retention tank of the daily tank of 560 m^3 of heavy fuel oil	29 m	18 °	27 m

The effect distances of the heat flows resulting from the bowl fire are listed in the following table.

Table 73 : Scenario 2 modeling results

<table>
<tr><th colspan="2" rowspan="2">Threshold values of the thermal flows</th><th colspan="3">Flow and distance on the length side</th><th colspan="3">Flow and distance on the width side</th></tr>
<tr><th>3kW/m²</th><th>5kW/m²</th><th>8kW/m²</th><th>3kW/m²</th><th>5kW/m²</th><th>8kW/m²</th></tr>
<tr><td rowspan="2">Thermal effects distances of the various tanks</td><td>Retention tank of the permanent storage tank of 3000 m³ of heavy fuel oil</td><td>66 m</td><td>45 m</td><td>27 m</td><td>43 m</td><td>29 m</td><td>17 m</td></tr>
<tr><td>Retention tank of the daily tank of 560 m³ of heavy fuel oil</td><td>41 m</td><td>30 m</td><td>21 m</td><td>34 m</td><td>24 m</td><td>17 m</td></tr>
</table>

X.7.3.2.5. Interpretation of the results

The results of the modeling of the fires of the retention tanks of various hydrocarbon storage tanks show that the effect distances associated with the threshold values of the thermal flows are confined at the inside of the power plant. There will be no external domino effects but on the other hand, synergies of accidents are possible because certain installations may be involved in the accident.

Taking these danger rays into account, prevention and protection barriers must be put in place in order to reduce the occurrence of this phenomenon but also to be able to cope with it in case of an occurrence.

The storage area must be prohibited from being used by strangers. Authorizations must be obtained for any intervention. Appropriate firefighting means must be established following preliminary sizing (in order to know the type, number and convenient locations).

To avoid overflowing of the tanks on the bowl it will be necessary to set up manual, automatic level gauges and level alarms on the tanks;

To counter bowl fires, foam weirs, monitor lances or mobile means can be used to create a foam mat that can contain or extinguish the fire. This foam mat must be maintained continuously to ensure its optimal effectiveness (because the foam decomposes after a while giving water and emulsifiers).

IX.7.3.3. SCENARIO 3: BIN FIRE

IX.7.3.3.1. Description of the accident

Following the fire in the hydrocarbon slick spilled on the retention tank, the hydrocarbon storage bin catches fire and emits thermal radiation. This scenario is studied for various storage facilities and only the thermal effects are evaluated.

IX.7.3.3.2. Effect distances evaluation methodology

The evaluation of the intensity of the thermal effects of this tank fire was carried out using the PRIMARISK tool based on the principles developed by INERIS arising from the model called "GT-DLI model" stated in the French circular no DPPR / SEI2 / AL-06-357 of January 31st 2007 related to the studies of dangers of deposits of flammable liquids. (See annex 6.3).

IX.7.3.3.3. Input parameters

The basic data necessary to make the calculations are listed in the following table.

Table 74 : Input parameters scenario 3

Product stored	Bin diameter	Bin height	Fire shape	Height of target
HFO permanent tank	16 m	16 m	Circular	1.5 m
HFO Buffer or daily tank	10.91 m	6 m		
LFO tank	7.99 m	4 m		

The environmental conditions used to make the calculations are as follows:

- room temperature: 25 °C;
- wind speed: 2.7 m/s;
- relative humidity: 0.84.

IX.7.3.3.4. Modeling results

The effect distances of the heat flows resulting from the fuel oil fire are listed in the following table.

Table 75 : Scenario 3 modeling results

Reference values of thermal flows		$3\ kW/m^2$	$5\ kW/m^2$	$8\ kW/m^2$
Distances of thermal effects for each storage bin	Heavy fuel oil bin of 3000 m^3 of volume	21 m	Not reached	Not reached
	Heavy fuel oil bin of 560 m^3 in volume	23 m	16 m	Not relevant

	Light fuel oil bin of 200 m^3 in volume	21 m	16 m	11 m

IX.7.3.3.5. Interpretation of results

The results of the modeling of the fire bin hydrocarbon storage show that the effect distances associated with the reference threshold values of the heat flows are confined inside the power plant. However, accident synergies are possible because some installations may be involved in the accident. It is important to set up a flame detector to detect any rise in temperature or the presence of product resulting from a combustion. Foam is the most used way to deal with a bin fire because water is ineffective in dealing with this kind of event. It would then be necessary to provide a reserve of sized emulsifiers provided with a premixing device. Hydrocarbons being apolar liquids, are hydrophobic and therefore do not dissolve in water. The most suitable type of emulsifier on flammable liquid bins is low expansion foam (heavy foam which can be sprayed at high distances). To extinguish a bin fire, it would first be necessary to extinguish the bowl fire if the retention has caught fire.

IX.7.3.4. SCENARIO 4: THIN LAYER BOIL-OVER

IX.7.3.4.1. Description and location of the accident

The fire in the light fuel oil storage tank causes the appearance of a thin layer boil-over phenomenon due to the vaporization of the water at the bottom of the tank following the temperature increases. After a few hours, a fireball formed over the tank which then exploded, emitting jets of hydrocarbon in flame. This accident scenario is only studied for the storage of 200 m^3 of light fuel oil. Only the thermal effects associated with this accident have been studied.

IX.7.3.4.2. Distance of effects evaluation methodology

The evaluation of the intensity of the thermal effects of a “thin layer” boil-over was carried out using a model implemented by PRIMARISK. This application is based on the so-called “GT-DLI model” described in French circular no. DPPR / SEI2 / AL-06- 357 of January 31st 2007 related to studies of the dangers of deposits of flammable liquids; Complements to the technical instruction of November 9th 1989 (See annex 6.4). This tool allows to evaluate the intensity of the thermal effects and the time of triggering of the phenomenon from the start of a bin fire.

IX.7.3.4.3. Input parameters

The basic data necessary to make the calculations are listed in the following table.

Table 76 : Input parameters-scenario 4

Parameters	**Values**
Diameter of the tank	7.99 m
Product initial height	3.5 m
Height of the tank	4 m
Stored product	Light fuel oil

IX.7.3.4.4. Modeling results

The effect distances of the thermal flow resulting from the phenomenon of a thin layer boil-over are listed in the following table.

Table 77 : Scenario 4 modeling results

Reference values (kW / m^2)	Effect distance at the edge of the bin (m)	Effect distance at the center of the bin (m)
3	15	19 m
5	15	19 m
8	10	14 m

According to the calculations, the boil-over time is estimated at 14 hours after the fire for an initial product height of 3.5 m.

IX.7.3.4.5. Interpretation of the results

The modeling results of the thin-layer boil-over of the light fuel oil storage tank show that the effect distances of the thermal flows do not go beyond the limits of the power plant. However, accident synergies are possible since certain installations may be involved in the accident.

IX.7.3.5. SCENARIO 5: CLASSIC BOIL-OVER

IX.7.3.5.1. Description of the accident

Following a bin fire, the water at the bottom of the heavy fuel oil tank boils and the piston effect causes the mass of hydrocarbon to rise. A huge ball of fire forms that explodes, causing fire jets and thermal effects. This scenario is developed for the permanent storage of heavy fuel oil as well as for the daily heavy fuel oil storage. Only the thermal effects have been studied.

IX.7.3.5.2. Distance effects evaluation methodology

The evaluation of the intensity of the thermal effects of a “classic” boil-over was carried out using a tool implemented by PRIMARISK. This tool is based on the calculation codes produced in the INERIS Omega 13 manual. It allows the intensity of thermal effects to be assessed (see annex 6.5).

IX.7.3.5.3. Input parameters

The basic data necessary to make the calculations are listed in the following table.

Table 78 : Input parameters-scenario 5

Type of storage	Bin volume	Hydrocarbon height in the tank	Bin height
Permanent heavy fuel oil storage tank	3000 m^3	14 m	16 m
Daily tank or heavy fuel oil buffer	560 m^3	5.7 m	6 m

IX.7.3.5.4. Modeling results

The effect distances of the heat flows resulting from the modeling of the classic boil-over phenomenon are listed in the following table.

Table 79 : Scenario 5 modeling results

Reference values of heat fluxes	3kW / m2	5kW / m2	8kW / m2

Distances of thermal effects for each model	Permanent storage tank for heavy fuel oil	440 m	351 m	260 m
	Daily tank or buffer heavy fuel oil	202 m	157 m	110 m

IX.7.3.5.5. Interpretation of results

Using upward hypothesis, the effect distances caused by a classic heavy fuel oil boil-over go beyond the limits of the site. The targets likely to be impacted are orchards and cultivated areas located in the surroundings of the site and undeveloped land. This Boil-over phenomenon was also modeled as part of this project by INERIS. The activation time is estimated at 2 days, 3 hours. The maximum radius of the fireball would be 148 m. The irreversible, lethal and significant lethal effect distances are 260, 351 and 440 m, respectively. In case of a fixed roof bin as it is the case here, a phenomenon leading to the disappearance of the roof and to a bin fire must be activated, an internal explosion for example, being understood that this explosion must not lead to the opening of the tank. The fire must then continue for the entire duration before the occurrence of the phenomenon, here 2 days and 3 hours.

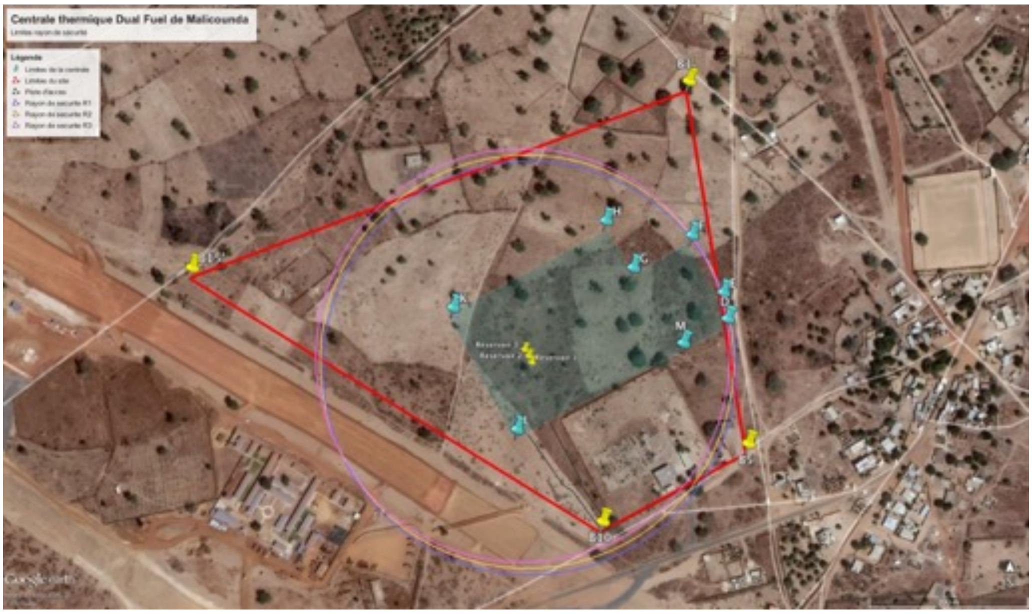

Image Google Earth 5 : Risk areas concerned by the heat flows resulting from the boil-over of a 3000m3 HFO tank

Analysis of the images above allows us to see that the thermal flows associated with the phenomenon of classic boil-over go beyond the limits of the site. A safety distance should be defined. Regarding the means of protection, for the concerned installation, the first safety measure is a drainage system at the bottom of the tank to drain the water continuously. **In the absence of water at the bottom of the tank, a Boil-Over phenomenon is impossible**. It should also be noted that, for the phenomenon to occur, the water must form, at the bottom of the tank, a continuous pool. Thus, for tank bottoms of concave or convex type, the amount of water required to activate a Boil-Over as calculated is relatively important. Thus, the probability of occurrence of the phenomenon will be significantly reduced in case of a tank with a concave bottom. The second important measure is organizational in nature with an IOP and the implementation, in case of a bin fire, of a foam extinguisher system designed to fight against the tank fire. These measures significantly allow to reduce the probability of the occurrence of the Boil-Over phenomenon. It should be noted that:

- the probability of annual occurrence of the Boil-over phenomenon is extremely low (of the order of 10^{-5} or 10^{-6} or even below);
- the kinetics of the phenomenon is slow and thus allowing, the mobilization of the agents and means of help and if necessary, the implementation of means of protection of the populations during the duration of bin fire.

Taking into consideration all these factors that can cause a boil-over, these prevention and mitigation measures below must be regularly implemented and tested to ensure the safety of people and property:

- Avoid bowl fires by:
    - avoiding overflowing of the tanks on the bowl by setting up manual, automatic level gauges and level alarms on the tanks;
    - establishing safety rules during filling;
    - using suitable tanks;
    - prohibiting the approach of open flames, smoking near storage areas, etc.;
    - requiring electrical authorizations during work that requires hot spots.

- Make regular purges of tanks;
- Use a quality fuel oil with a very low percentage of water if possible;
- In case of a bowl fire, evacuate the entire area likely to be reached by the flames;
- Put out the flames as quickly as possible;
- Decrease the storage capacity
- Divide the storage area and set up a fire wall;
- Provide cooling rings and foam chambers above the tanks;
- Train staff for fire detection and fire-fighting;
- Establish appropriate fire-fighting means;
- Establish a safety distance between the storage area and the first installations and the outside of the power plant.

IX.7.3.6. SCENARIO 6: TRANSFORMER EXPLOSION

IX.7.3.6.1. Description of the accident

Due to the presence of humidity and a lack of maintenance, a short circuit appeared on the transformer. This led to the explosion of the installation.

IX.7.3.6.2. Distance effects evaluation methodology

The PROJEX method developed by INERIS was used to evaluate the distances of overpressure effects during the explosion of the transformer station. This method combines a Brode calculation for energy and a multi-energy index for pressure effects. It is based:

- on the Brode equation to determine the available energy of explosion;
- on the multi-energy method to assess the attenuation of the pressure effects.

IX.7.3.6.3. Input parameters

The basic data necessary to make the calculations are listed in the following table.

Table 80 : Input parameters-Scenario 6

Parameter	Value
Volume	200 liters
Stored product	Oil
Breaking pressure	0.152 MPa

IX.7.3.6.4. Modeling results

The explosive energy calculated is 182.4 kJ. The effect distances of the shock wave resulting from the explosion of the transformer are listed in the following table.

Table 81 : Scenario 6 modeling results

Reference values (mbar)	Effect distance (m)
50	6.2
140	2.8
200	1.8

IX.7.3.6.5. Interpretation of the results

The results obtained following the modeling of the explosion of the transformer show that the effect distances of the shock wave are very minimal therefore, will not go beyond the site limits and the damage will be limited to the immediate environment of the transformer station. It is necessary to resort to mechanical protection of the transformers while ensuring the empowerment of the people who intervene on these installations. The electrical circuits that supply the transformers must be regularly checked. The cooling of the dielectric oils as well as their draining frequency must be respected to avoid overheating of the oils. Transformers must be equipped with lightning conductors to isolate them from electrostatic discharges in case of a lightning strike. Above all, we should not forget the preventive and curative maintenance that allows to detect anomalies very early to avoid the risk of accident.

IX.7.3.7. SCENARIO 7 : BOILER EXPLOSION

IX.7.3.7.1. Description of the accident

Following an overpressure phenomenon due to a system failure, the steam cylinder of the boiler burst. This accident causes overpressure effects, the effect distances of which are identified below.

IX.7.3.7.2. Evaluation methodology of the Distance effects

The PROJEX method developed by INERIS was used to evaluate the distances of overpressure effects during the bursting of the steam tank of the boiler. This method combines a Brode calculation for energy and a multi-energy index for the pressure effects. It is based:

- on the Brode equation to determine the available energy of explosion;
- on the multi-energy method to assess the attenuation of the effects of pressure.

IX.7.3.7.3. Input parameters

The basic data necessary to make the calculations are listed in the following table.

Table 82 : Input parameters -scenario 7

Characteristic	Value
Volume of the steam tank	6 m^3
Burst pressure	26 00 000 Pa
Atmospheric pressure	101 325 Pa
Ratio of the specific heats of the gas contained in the combustion chamber	1.314

IX.7.3.7.4. Modeling results

The effect distances of the overpressure wave due to the explosion of the boiler are given in the table below.

Table 83 : Scenario 7 modeling results

Reference values related to the overpressure effects	Explosion energy	Distance from the overpressure effects
20 mbar	4.93 600,000 joules	99.9 m
50 mbar		49.9 m
140 mbar		22.7 m
200 mbar		14.5 m

IX.7.3.7.5. Interpretation of results

The results of the modeling of the explosion of the boiler show that the effect distances of the thermal flows do not go beyond the limits of the power plant. However, accident synergies are possible since certain installations may be involved in the accident. The strategies for reducing the potential danger related to the operation of the boiler as well as the means of protection can be summarized by:

- Promoting an inspection and a maintenance on several scales of the installation;

- Establishing a natural or arterial ventilation so as to avoid the formation of an explosive atmosphere;
- Establishing a fire wall in the boiler room so as to mitigate the thermal effects following a fire;
- Providing fire-fighting equipment;
- Installing a safety valve above the boiler;
- Installing a temperature and pressure sensors;
- Limiting and regulating the access to the premises;
- Empowering and training of the staff in charge of handling the Boiler.

IX.7.4. SUMMARY OF THE DETAILED RISK ANALYSIS

The detailed risk analysis allows to model certain dreaded events deemed important. The modeling results have shown that all the effect distances obtained are confined inside the power plant, with the exception of the heavy fuel oil boiler-over, the distances of which exceed the property limits.

Thus, the heavy fuel oil boil-over scenario is likely to cause major risks and internal domino effects like all other modeled scenarios except the transformer’s explosion, the effects of which will be limited to the immediate environment of the electrical substation.

The following table is a summary of the results of the models made from different scenarios of studied accidents.

Table 84 : Summary of the modeling results of various scenarios of studied accidents

Scenario	Effects and kinetics	Model	Distances of thermal and or overpressure effects (in m)			Reaching targets in the site environment		Means of prevention and safety measures
			EI	EL	ELS	Inside	Outside	
Scenario 1: Explosion of the gas ceiling of the tank	Overpressure effects Fast kinetics	Tank of 3000 m^3 of heavy fuel oil	76	35	26	Yes Possibility of synergistic accidents	No	Compliance with storage conditions Compliance with the regulatory distances between two storage units Staff empowerment Availability of a fire detection and extinction detection means Tanks degassing and atmosphere control prior to any activity
		Tank of 560 m^3 of heavy fuel oil	43	20	15			
		Tank of 200 m^3 of fuel oil light	31	14	11			
Scenario 2: Retention tank fire	Thermal effects Fast kinetics	Tank of 3000 m^3 of heavy fuel oil	66 side length 43 side width	45 side length 29 side width	27 side length 17 side width	Yes Possibility of synergistic accidents	No	Grounding of metal equipment Prohibition to approach open fire from the storage area Preventive inspection and maintenance of the tanks Fire extinguishing equipment near the storage area Staff awareness and training
		Tank of 560 m^3 of heavy fuel oil	41 side length 34 side width	30 side length 24 side width	21 side length 17 side width			
Scenario 3: Bin fire	Thermal effects	Tank of 3000 m^3 of heavy fuel oil	21	NA	NA	Yes	No	Grounding of metal equipment

	Fast kinetics	Reservoir 560 m^3 of heavy fuel oil	23	16	Not relevant	Possibility of synergistic accidents		Inspection and monitoring procedure appropriate protection of the coat Fire permit during hot spot operation Presence of cooling ring above the tanks Presence of foam, extinguishing material
		Tank of 200 m^3 of light fuel oil	21	16	11			
Scenario 4: Thin layer Boil-over	Thermal effects Slow kinetics	Tank of 200 m^3 of light fuel oil	15 edge of tank 19 center of tank	15 edge of bin 19 center of bin	10 edge of bin 19 center of bin	Yes Possibility of synergistic accidents	No	Periodic emptying of storage tanks Presence of fire-fighting means Rapid extinction of fire Rapid intervention by qualified persons
Scenario 5: classic Boil -over	Thermal effects Slow kinetics	Tank of 3000 m^3 of heavy fuel oil	440	351	260	Yes Possibility of synergy accidents	Yes Possibility of major risks	
		Tank of 560 m^3 of heavy fuel oil	202	157	110			
Scenario 6: Explosion of transformer	Overpressure effects Fast kinetics	Electric transformer	6.2	2.8	1.8	No	No	Lightning protection Preventive inspection and maintenance of equipment Oil drainage to a hydrocarbon separator Well-sized fire network, FHC, Appropriate fire extinguishers
Scenario 7: Bursting of the steam tank of the boiler	Overpressure effects Fast kinetics	Recovery boiler	99.9	49.9	14.5	Yes Possibility of synergistic accidents	No	Temperature and pressure sensors Preventive inspection and maintenance of equipment, regular control of water from the PDD

								Limited and regulated access in case of operation in combined cycle Staff empowerment

IX.8. MEANS OF PREVENTION DETECTION AND INTERVENTION

In order to prevent the occurrence of a major accident or limiting the consequences on people, property and the environment, the power plant will need safety barriers (or elements critical to safety).

IX.8.1. MEANS OF PREVENTION

The various measures taken to prevent dreaded events are technical and organizational.

IX.8.1.1. TECHNICAL MEANS

The establishment of a control room is necessary in order to centralize all the information and supervise the operations and process. The operators in charge of monitoring and controlling the equipment, installations and processes must be trained and authorized to carry out certain delicate and precise operations such as:

- the activation / deactivation of the power plant;
- the regulation of the fuel level in the storage tanks to avoid overfilling and under filling;
- the activation / deactivation of the transfer and centrifugal pumps;
- the regulation of the quality of fuel and air in the combustion chamber;
- the regulation of the temperature and pressure in critical equipment;
- the regulation of injection of chemicals to fight against corrosion, for the production of demineralized water.

The power plant must therefore have a back-up generator, and must be connected to the SENELEC network to supply electrical power to the safety equipment in case of loss of electricity.

It is recommended that the power plant has backup pumps taking over from the main pumps in the event of a malfunction (one pump in normal operation and another in stand-by mode for each circuit).

General measures to prevent sources of ignition have been recommended. These include:

- fire permit;
- grounding devices for equipment and metal mass;
- lightning protection devices;
- fire-fighting means.

Regarding the supply and storage of fuel oil, these provisions must be adopted to prevent any risk of accident:

- double check the driver's authorization;
- make the driver aware of the dangers of the product he is transporting;
- double check the availability of the SDS of the product transported in the vehicle;
- avoid using busy lines of communication during rush hour;
- ensure the installation of danger pictograms on tank trucks;
- comply with the dimensions and technical specifications applicable to containers and retentions;
- comply with the regulatory distances between two tanks and between storage and buildings;
- identify the ATEX areas and establish restrictions on the use of these premises;
- put up danger signs in all risk areas;
- establish very strict procedures for working in these areas for the unloading and storage of hydrocarbons;
- put in place adapted fire-fighting means.

IX.8.1.2. OPERATIONAL RESOURCES

Operational devices are measures that contribute to the risk reduction process on the site.

Fire prevention and fire-fighting training must be provided periodically to all operating personnel. There must be an operational, first intervention team on the site, capable of raising the alarm and quickly reacting in case of a disaster; which means you have to develop an IOP.

The maintenance manager must set up a preventive inspection and maintenance plans in order to:

- carry out a precise and methodical monitoring of the condition of the equipment to better prepare for the maintenance and better follow the procedure;
- anticipate any equipment failure.

Awareness sessions for local residents should also be planned to inform them of the potential risks to which they are exposed and the safety measures to be taken to avoid possible accidents.

IX.8.2. MEANS OF DETECTION

Means of detection are equipment and procedures for detecting an anomaly.

Organizational detection systems are mainly based on operator rounds, while technical systems are, among other things:

- turbine vibration sensor;
- flame and absence of flame controller in the combustion chamber;
- temperature and pressure sensor in the steam lines;
- temperature and pressure sensor in the combustion chamber;
- water conductivity control at the demineralization station;
- control of the quality of process water leaving the neutralization tank;
- high- and low-level sensor on fuel storage tanks;
- temperature, pressure sensor in fuel storage tanks;
- sensor of flow, pressure on fuel storage line and of fuel transfer;
- control of the pressure of the oil return line;
- smoke detector;
- level detector.

IX.8.3. MEANS OF INTERVENTION AND CONSEQUENCES MITIGATION

In addition to the ability of automatic or manual activation/deactivation of all power plant equipment by operators and good training in fire prevention and fire fighting for the entire personnel, the power plant must have other means of intervention and mitigation of consequences such as:

- triggering the IOP;
- fire-fighting equipment (water tank, FHC, fire extinguisher, etc.);
- general and selective alarms;
- emergency exits;
- regrouping points;
- a direct line with the firefighters;
- first aid kits;
- PPE for protection against fire and chemical risks;
- safety and eye showers;

- etc.

Exercises on the IOP must be regularly performed in order to consider its effectiveness in face of dangerous situations, to improve loopholes if they exist and mainly to master the security measures to be taken in case of a disaster.

Procedures to raise awareness of the risks related to the activities of the power plant must be drawn up for staff, subcontractors and visitors.

Access must be strictly secure and a strict identification procedure must be imposed at the entrance to the power plant for both staff and visitors

IX.9. ANALYSIS OF PROFESSIONAL RISKS

IX.9.1. OBJECTIVE

Occupational risks lead to accidents at work and occupational diseases. In order to preserve the physical integrity and health of workers, an analysis of occupational risks is necessary at each workstation.

Occupational risk assessment is an important part of safety that allows to take the necessary precautions to protect the health and safety of employees. It consists of identifying all risks involved in each position and working condition and proposing solutions for the prevention against these risks and the protection of the exposed persons. This occupational risk assessment is a regulatory obligation defined in article 5 of decree 2006-1256 related to employers' obligations in health and safety at work. It helps in planning preventive actions and is the basis of any approach to improve safety and working conditions. It is the responsibility of the employer and must be done at each workstation.

IX.9.2. METHODOLOGY

The assessment of occupational risks consists in identifying the risks, prioritizing them and then planning the prevention actions adapted to each identified risk.

It should be noted that this assessment of professional risks is made before the design of workstations. Therefore, it will have to be readjusted to the context once the construction of the power plant has started.

The following methodology was adopted:

1. Make an inventory of workstations;
2. Identify the risks at each workstation (make an inventory of the intrinsic properties to the equipment, products, work method, which could cause damage to the health of the employees);
3. Classify the risks according to a rating (frequency and severity) in order to be able to prioritize preventive actions;
4. Propose effective and adapted prevention actions in order to reduce the frequency of occurrence of the identified risks and reduce their severity.

The identification of occupational risks is based on feedback (accidents and occupational illnesses occurring in similar activity sectors), regulations and on a visit to a similar site. The experience of the Contour Global power plant has been taken into account.

A rating system has been adopted to prioritize the various risks. It is based on:

- the frequency of occurrence of the accident, the incident or the occupational disease and

- the severity of the accident, the incident or the occupational disease.

The levels required for frequency and severity rating are presented in the following table.

Table 85 : Quotation scale for operational risks

Frequency scale (F)		**Severity scale (G)**	
Score	**Meaning**	**Score**	**Meaning**
F1	Once every 10 years or less	**G1**	Reversible lesions without AT or with AT less than 2 days
F2	Once per year	**G2**	Reversible lesions, with AT
F3	Once a month	**G3**	Irreversible lesions, Permanent incapacity
F4	Once a week or more	**G4**	Deaths

This rating scale makes it possible to establish a criticality matrix represented by different color codes. These colors testify the gravity of the facts and give an orientation on the order of priority to be given to the preventive measure.

Table 86 : Matrix of risk criticality

	F1	F2	F3	F4
G4				
G3				
G2				
G1				

The green color represents a low risk. In this case, the priority of prevention actions is of order 3.

The yellow color represents a moderate risk. In this case, the priority of the prevention actions is of order 2.

The red color represents a high risk. In this case, the priority of the prevention actions is of order 1.

	High risk-Priority 1
	Moderate risk-Priority 2
	Low risk-Priority 3

All the risks which can lead to death are of priority 1 even if their frequency of occurrence is low.

IX.9.3. PRESENTATION OF THE RESULTS

IX.9.3.1. WORKSTATIONS INVENTORY AND TYPOLOGY OF IDENTIFIED OCCUPATIONAL RISKS

The division into work units is based on the different activities carried out. Those with similar risk categories have been grouped together.

The types of risks potentially incurred by workers at the power plant are as follows:

- risks related to the use of earth-moving machinery;
- risks related to the use of manual tools;
- risks related to manual handling;
- risks related to repetitive gestures;

- risks related to noise;
- risks related to work in hot weather;
- road risks;
- risks related to the use of handling equipment;
- risks related to falling objects;
- risks related to the use of machines;
- risks related to mechanical handling;
- risks related to manual handling;
- risks related to repetitive gestures;
- risks related to falls (height, ground floor);
- electrical risks;
- chemical risks;
- risks related to working on screens;
- risks related to working in confined spaces;
- risks related to thermal environments;
- risk of fire and explosion.

IX.9.3.2. IDENTIFICATION AND ASSESSMENT OF OCCUPATIONAL RISKS

The different risks to which the staff may be exposed to during the construction and operation activities of the power plant are set out in the following table.

Table 87 : Analysis of occupational risks

Project phase	Activities	Exposed staff or station	Identified risks	Potential damage (injuries, damage to health)	Gi	Fi	Ri	Preventive measures
Construction phase	Earthworks	Staff performing the work Machine operators Staff present on site	Risks related to the use of earth-moving machinery	Collision machine/machine; machine/person Injury	2	3		Set up signs and a circulation plan on the jobsite Provide audible warning systems Train machine operators on safe driving rules Do not block traffic lanes Properly store spoils Assist conductors during excavations
			Risks related to the use of manual tools	Cut Fractures	3	4		Train the staff on the handling of these tools Equip the staff with protective gloves

			Risks related to manual handling	TMS Muscle aches	2	3		Limit daily load Train staff on manual handling techniques Provide employees with mechanical aids Establish rest periods
			Risks related to repetitive movements	MSD Muscle aches	2	3		Introduce rest periods Establish rotating teams Provide employees with mechanical aids
			Risks related to same-level falls	Injuries Fractures	2	3		Organize storage Mark and put signs on risk areas
			Risks related to noise	Temporary or permanent hearing loss	3	2		Use quieter devices Provide workers with hearing protection and ensure their proper use
			Risks related to work in high heat	Heatstroke Dehydration	2	4		Avoid working in exposed areas at the hottest hours of the day

								Provide shelters for workers (ex. scrap Concessionaires) Provide refreshing drink to workers Include breaks in work schedules
Construction phase	Transport of equipment to the site by trucks and cranes	Driver or staff present on the site	Road risk	Collisions vehicle/vehicle Bump vehicle/pedestrian Injury Death	4	2		Train drivers on the rules of conduct Educate drivers on the respect of the traffic rules Use vehicles in good condition Avoid using heavy traffic roads during peak hours
			Risks related to the use of handling machines	Collision machine/vehicle Bump vehicle/pedestrian Injury Death	4	2		Establish a circulation plan Define and mark out the area of influence of the machine

								Train the machines drivers on the rules of conduct Use people authorized to handle this kind of machines Clear traffic plans and work plans Assist the driver during the transportation
			Risks related to falling objects	Injury Fractures Death	4	2		Ensure the performance of the machine Equip the personnel on site with safety helmet and shoes Limit the storage heights Mark the work area
			Risks related to work in high heat	Heatstroke Dehydration	2	4		Avoid working in exposed areas at the hottest hours of the day Provide refreshing drink to workers

								Include breaks in work schedules
Construction phase	Unloading of equipment	Unloading staff Staff present on the unloading circuit	Risks related to mechanical handling	Death Injury Fractures	4	2		Set up a circulation plan Delimit and mark out the area Train drivers of vehicles on the rules of conduct Use people authorized to handle this type of engines Release traffic plans and work plans Assist the driver when transporting
			Risks related to manual handling and repetitive gestures	TMS Muscle aches	2	3		Limit the daily load Train staff on manual handling techniques Provide employees with mechanical aids

								Establish rest periods
			Risks related to falling objects	Wounds Fractures Death	4	2		Equip the staff on site with helmets, safety mask and shoes Limit storage heights Mark out the work area
			Risks related to work in high heat	Heatstroke Dehydration	2	4		Avoid working in exposed areas at the hottest hours of the day Provide refreshing drink to workers Include breaks in work schedules

Construction phase	Welding work	Staff performing the work	Chemical risks	Burns Injury Respiratory diseases Eye or skin irritation in case of repeated or prolonged contact with the product Allergies	3	3		Provide workers with PPE (glasses, mask, helmet, gloves, etc.) and require them to be worn Ensure that the staff is qualified Limit the potential number of exposed personnel
Operation phase	Installation of equipment (mechanical or manual)	Personnel performing the work or machine operator	Risk related to mechanical handling	injuries Fracture Death	4	2		Establish a circulation plan Define and mark out the area of influence of the machine Train the drivers of the machines on the rules of conduct

								Use people authorized to handle this kind of machines Release traffic plans and work plans Assist the driver when transporting
			Risks related to manual handling and repetitive gestures	TMS Muscle aches	2	3		Limit daily load Train staff on manual handling techniques Provide employees with mechanical aids Establish rest periods
			Risks related to testing (calibration) of machines	Injury Burn Electrification Electrocution Temporary or permanent hearing loss	4	2		Establish a clearly identifiable emergency stop device on the machines Clearly identify the control devices to avoid unintentional start-ups Put on machines safety devices

								Check the conformity of equipment by an approved organism Regularly check the electrical circuits Give instructions for working on stationary machines Educate employees on the safety rules to adopt Equip employees with PPE and require them wear it
			Electrical risk	Death Electrification Burn	4	2		Check the empowerment of the staff carrying out the work Train the staff on the measures to be taken in case of a fire Control the electrical installations regularly

Operation phase	Operation of the machines	Staff in charge of controlling the installations (control room)	Risk related to work on screen	Fatigue Visual disturbances TMS Headaches Body aches	3	3		Adjust workstations to have a comfortable posture Put curtains on windows Use ergonomic desks
Operation phase	Inspection and maintenance of machines	Staff performing the work	Risk related to noise	Temporary or permanent hearing loss	3	2		Use less noisy machines Provide staff with hearing protection (helmets; ear plugs ...) and ensure that they are used
			Electrical risk	Electrocution Electrification Burning	4	2		Regularly control electrical installations Ensure the empowerment of the staff

								Train staff about the measures to be taken in case of fire
			Risks related to falls from a height, on the same level	Injury Fractures	2	3		Mark and report slippery areas
			Risks related to isolated work	Injuries Fracture Burn	2	3		Reduce the frequency and duration of interventions Establish safety instructions Establish means of control at sight
			Risks related to working in a confined space	Injury Respiratory problems	2	3		Defining the operating modes before intervention Work in pairs Ventilate confined spaces before intervention Have respiratory mask

			Risks related to thermal environment	Heatstroke Burning	2	4		Provide work clothes suitable for temperatures
Operation phase	Hydrocarbon unloading	Staff unloading trucks	Chemical risks	Respiratory diseases Eye or skin irritation Allergy	4	3		Provide suitable PPE and ensure it is worn Establish strict safety instructions to be followed
			Fire and explosion risks	Burns Death Poisoning by smoke	4	3		Prohibit the approach of the flame source in the unloading area implement fire-fighting means
Operation phase	Administrative work	Administrative staff	Risks related to falls on the same level; falls from height levels	Injuries Fracture	2	3		Mark up and put signs on risk areas

			Risk related to screen work	Fatigue Visual disturbances TMS Headaches Body aches	3	3		Arrange workstations so as to have a comfortable posture Put curtains on windows Use ergonomic desks
Operation phase	Guarding	Security staff	Risks related to working postures	TMS Fatigue, body aches	1	4		Create a comfortable space for the guards Divide the guard per shift
			Risks related to weather conditions	Heatstroke Dehydration Snap cold Cold	1	4		Make a shelter for the guards Provide them with a drinking water point
			Risks related to external aggressions	Injuries Death	4	1		Establish a direct link with the firefighters and the police station Employ qualified personnel
Operation phase	Other related activities (cleaning, delivery,	Subcontractor staff	Risks related to same-level falls	Injuries Fracture	2	3		Mark up and put signs on areas at risk

	service except maintenance, etc.)		Risks related to mechanical handling	Injuries Fracture Death	4	2		Establish a circulation plan Delimit and mark out the area of influence of the engine Train operators on the rules of conduct Hire people authorized to operate this type of engine Draw up circulation plans and work plans Assist the driver during transportation
			Risks related to manual handling and repetitive gestures	TMS Muscle aches	2	3		Limit daily load Train staff on manual handling techniques Provide employees with mechanical aids Establish rest periods

IX.9.4. RECOMMENDATIONS

Risk assessment professionals reveals the existence of high risks whose prevention actions are a top priority. Moderate as well as low risks have been identified. Recommendations have been made for the construction and operation phases in order to minimize the frequency of occurrence of risks and their severity.

IX.9.4.1. RECOMMENDATIONS IN THE CONSTRUCTION PHASE

The managers in charge of the construction must:

- carry out an analysis of occupational risks at each workstation;
- carry out an occupational risk prevention plan;
- appoint an HSE manager on site;
- provide workers with PPE adapted to each workstation and require them to wear it.

This risk analysis as well as the prevention plan are not fixed. They must be periodically reviewed according to changes of equipment, processes or work phase.

Employees must be made aware of the occupational risks and the importance of respecting the implemented prevention measures. These documents must be presented to any subcontractor engaged in the construction phase.

IX.9.4.2. RECOMMENDATIONS IN THE OPERATION PHASE

During the operation phase, an analysis of the occupational risks at each workstation will also be necessary. Subsequently, a plan for the prevention of occupational risks must also be implemented.

The risk analysis will have to be periodically updated according to the changes that could be made.

All site employees and subcontractors are concerned and must be made aware of the risks involved as well as the means of prevention to be adopted.

It is necessary to set up a CHST and assert the 9 principles of prevention which are:

1. Avoid the risks

2. Evaluate the risks that cannot be avoided

3. Prevent the risks at the source

4. Adapt the work to humans

5. Take into consideration the development of the technique

6. Replace what is dangerous by what is not or by what is less dangerous

7. Plan prevention

8. Prioritize collective protection measures

9. Train and inform employees about the risks and their prevention

In general, it is important that the manager of the power plant, the administration and employees are involved in the process of reducing occupational risks. The management methods to be developed must comply with the rules of ethics and professional conduct.

Transparency in the processes and procedures is a major asset allowing the adoption of the implemented rules. The objectives must be clearly defined.

The manager should be an example for his employees. Thus, for a successful management system, he must be the first to show his commitment and determination. He should be actively involved in the development and supervision of the prevention approach and in its implementation.

The facts of the working situations and conditions must be taken into account when developing rules and procedures. Communication sessions on health and safety at work are also necessary in order to raise staff awareness and develop a risk culture in them.

Staff acceptance is a key condition in the implementation of a risk prevention policy. Therefore, their opinion must be taken in consideration before taking any decision related to them and they must be associated with the choice of PPE to guarantee their safety.

Social dialogue must be integrated into the company's routine. It goes through the engagement of employees, staff representatives, and the implementation of the prevention policy.

IX.10. CONCLUSION OF THE RISK ASSESSMENT

This risk study revealed the presence of risks that could affect the physical integrity of the workers as well as the populations surrounding the site.

Based on the preceding actions risk analysis and the modeled accident scenarios, domino effects are likely inside and outside the site. Using major hypothesis, the effect distances caused by a classic heavy fuel oil Boil-over go beyond the site limits. The targets likely to be impacted are orchards and cultivated areas located in the site's surroundings, the toll highway and undeveloped land. This Boil-over phenomenon was also modeled as part of this project by INERIS. The models of the consequences of a Boil-Over phenomenon and the determination of the various intermediate parameters, according to the methodology described in the INERIS report Ω 13, were made on the basis of a storage tank of 16 m in diameter and 16 m height up to a height of 14 m of liquid, at the fire outbreak. The activation time is estimated at 2 days, 3 hours. The maximum radius of the fireball would be of 148 m. The irreversible, lethal and significant lethal effect distances are of 260, 351 and 440 m, respectively. Regarding the means of protection, for the concerned installation, the first safety measure is a drainage system at the bottom of the tank to continuously drain the water. **In the absence of water at the bottom of the tank, a Boil-Over phenomenon is impossible**. It should also be noted that, for the phenomenon to occur, the water must form, at the bottom of the tank, a continuous aquifer. Thus, for tank bottoms of concave or convex type, the amount of water required to activate a Boil-Over as calculated is relatively important. Thus, the probability of occurrence of the phenomenon will be significantly reduced in the case of a tank with a concave bottom. The second important measure is of organizational nature with an IOP and the implementation, in case of a tank fire, of a foam extinguisher system designed to deal with the tank fire. These measures significantly allow to reduce the probability of occurrence of the Boil-Over phenomenon. It should be noted that:

- the probability of annual occurrence of the Boil-over phenomenon is extremely low (of the order of 10^{-5} or 10^{-6} or even below);
- the kinetics of the phenomenon is slow and thus allowing, the involvement of the agents and means of help and if necessary, the implementation of means of protection of the populations during the duration of the tank fire.

The power plant, that covers approximately six (06) ha, is located within an 18-ha site. **Also,** given the very low probability of the occurrence of the boil-over phenomenon, of its fairly long activation time allowing the organization of rescue and evacuation of human targets, the establishment of means of prevention, intervention and protection, the safety distance can be reduced to the radius of significant lethal effects (260m).

X. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

X.1. INTRODUCTION

The Environmental and Social Management Plan (ESMP) aims to ensure the right implementation, and in a timely manner, of all measures to mitigate negative impacts and enhance positive impacts.

The objectives of the ESMP are, among others, to:

- ensure that the project activities are undertaken in accordance with all legal and regulatory requirements;
- ensure that the environmental challenges of the project are well understood by the promoter and implemented both in the construction and operational phase.

The environmental management plan includes various measures:

- the measures to be included in the different terms and conditions of the contracting companies for works as contractual measures that will not be evaluated financially since they are included in the works' tender documents;
- the support measures to be carried out in addition to the technical and / or environmental actions which will be assessed financially, for example awareness-raising and training actions (institutional strengthening of stakeholders).

The ESMP will be revised when necessary to ensure its relevance and effectiveness. The proposed changes will be discussed with the relevant government authorities.

This ESMP will include:

- regulatory and administrative measures;
- environmental and social management procedures;
- mitigation and improvement measures for impacts during the construction and operation phase;
- project monitoring and follow-up measures;
- the actors involved in the implementation of the ESMP and their responsibilities.

It is important to set up an Environmental and Social Management System (ESMS).

X.2. REGULATORY AND ADMINISTRATIVE APPROVAL APPLIED TO THE PROJECT

This involves ensuring compliance with the administrative procedures and regulations in force, in particular:

- the authorization to operate facilities classified for environmental protection (ICPE);
- the authorizations required for the production of electrical energy;
- the authorization to build the power plant;
- the declaration of the opening of a site;
- the authorization to operate a drilling;
- the environmental and social regulations.

X.2.1. APPROVAL TO OPERATE AN ICPE

In accordance with the provisions of the Environment Code, the proponent must, before operating the power plant, send an **operating license request, in five copies,** to the Minister responsible for the environment (art. R.5 of the Environment Code).

Said request must be the subject of a public inquiry by decree of the Governor of the Region of Thiès for a period of 15 days (art. R.6 of the Environment Code).

This request mentions:

1. The first names, surname and residence of the applicant, in case of a natural person.

In case of a legal person, its corporate name or company name, its headquarter, as well as the status of the signatory of the request;

2. The location on which the establishment will be installed;

3. The nature and volume of the activities that the applicant intends to carry out, the manufacturing procedures that he implements, the materials that he uses and the products that he manufactures, the wastewater disposal system and other gas cleaning systems that are planned or installed.

The following documents are attached to the authorization request file:

- An identity document of the applicant or receipt for GIE and status for company;
- A situation plan at a scale of $1/1000^{th}$ or $1/2000^{th}$ indicating the landmarks allowing to locate the site;
- A ground plan on a scale of $1/1000^{th}$ specifying the activities of the immediate surroundings;
- An installation plan on a scale of $1/200^{th}$ or $1/100^{th}$ indicating the usage of buildings and specifying the details of the equipment in the establishment as well as the location of the emergency means. To this plan are attached notices, legends or descriptions;
- A study or an express declaration, indicating the nature, the toxicity of the residues of the operation. This study must specify the emergency means in case of an accident and the measures to be taken to reduce and counter the effects of a disaster.

X.2.2. ENVIRONMENTAL DISCHARGE

The obtaining of the environmental discharge is subject to the validation of this study that is done at two levels:

First level of validation by the National Technical Committee composed of the technical services of the State concerned by the project that convenes a session of work to present the results of the study and amend the document;

Second level of validation by local populations through a public hearing to be held in the project reception area.

The validation phase of the study is the last step in the process of obtaining an environmental discharge certifying that the ESIS of the project has been approved by the competent authorities and that all the environmental and social sensitivities likely to be impacted have been taken into consideration and that effective and realistic measures have been proposed for good management of the implications of the project.

The different stages of the process are summarized below:

- Drafting of the TOR for the study by the proponent and filing to the DEEC;
- Validation of the TOR by the DEEC and the other competent technical services after a field visit;
- Drafting of the provisional report and submission to the DEEC;
- Holding of the Technical Committee for a first validation of the report;
- Correction and submission of the pre-validated report with inclusion of the technical committee's comments;
- Programming and holding of the public hearing in the project's host municipality in local language aiming at the second validation by the populations;
- Submission of the final report with the inclusion of the observations of the populations following the public hearing.

The environmental permit is issued following the validation of all stages of this procedure.

X.2.3. CONSTRUCTION APPROVAL

In accordance with the provisions **of the Town Planning Code**, law no. 2008-43 of August 20th 2008 relating to the Town Planning Code and decree no. 2009-1450 of December 30th 2009 require SENELEC to obtain a construction approval before the start of any activity.

This approval is issued after notice from the departments responsible for the industry, the environment, the regional planning and civil protection. Any request for construction approval must include the following information (art. R368):

- the nature of the establishment;
- the power plant cadastral plan certified by a surveyor and approved by the land registry services and the architectural plans certified by a certified architect;
- the class in which it should be placed;
- an impact study for first class establishments;
- a detailed description of the work;
- a safety notice;
- the mode and conditions of disposal, use and treatment of wastewater and waste;
- the layout of existing sewers;
- the emergency means against the effects of a possible disaster, and all measures taken to satisfy the measures provided by the regulations in force.

It is also necessary to present to the authority responsible for issuing the construction approval an execution file before the start of work.

X.2.4. CLEARANCE APPROVAL

Any deforestation, clearing or reforestation activity will require compliance with all of the procedures established by the Forest Code. Before the start of these activities related to the vegetation in place, the proponent must approach the local authorities, in particular the town hall, that is responsible for the Water and Forest Service.

However, SENELEC has signed a memorandum of understanding with the Directorate of Water and Forests authorizing them to cut down forest species regardless of their status for public utility projects.

X.2.5. WATER INTAKE APPROVAL

Within the framework of this project, SENELEC must provide an approval to dig drilling intended for ensuring the supply of water to the power plant, after investigation, by the Ministers responsible for Hydraulics and Sanitation by following the procedures described in section I (Art.L8 to L 23) of the Water Code concerning authorizations as well as in implementing decree no. 98-556 of June 25th 1998 (chapter 4: legal framework).

X.2.6. PRIVATE INDEPENDENT POWER PRODUCER APPROVAL (IPP)

The operator of the power plant must obtain from the Ministry of Petroleum and Energies, various approvals, licenses and concessions provided for in accordance with Law No. 98-29 of April 14th 1998, which is supplemented by decree no. 98-334 of April 21st 1998, relating to the electricity sector which regulates the activities of production, transport, distribution and sale of energy.

In fact, it is the Ministry of Petroleum and Energies which is empowered by decree to grant authorizations, licenses or concessions, with the support of the Electricity Sector Regulation Commission

X.3. IMPACTS MANAGEMENT PLAN

X.3.1. INTRODUCTION

The construction and operation phases of the project will inevitably generate impacts that are either positive or negative. Impact management measures have been defined and will have to be applied in order to optimize these positive impacts of the project and to mitigate, failing to avoid negative ones.

- **Improvement measures**

These measures aim to add value to or sustain the positive impacts expected from the project.

- **Mitigation measures**

These measures consist in modifying certain aspects of the project in order to remove or reduce its negative effects on the environment.

The modifications may relate to three aspects of the project, namely: its design, its implementation schedule (construction and operation phase) and the implementation site.

- **Compensation measures**

Compensation measures of an exceptional nature occur when no possibility of eliminating or reducing the impacts of a project has been determined. Their implementation allows to offer a counterparty, in particular, the restoration as much as possible of the initial conditions

X.3.1. IMPACTS IMPROVEMENT PLAN IN THE CONSTRUCTION AND OPERATION PHASE

Table 88: Improvement measures of the positive impacts during the construction and operation phases

Impacted components	Activity / Source of impact	Potential impacts	Improvement measures	Indicators for monitoring measures	Means of verification	Deadline for completion	Responsible for implementation
Socio-economic activities	Preparation and construction work Operation of the power plant	Job creation	Involve the Regional Labor Inspectorate for the identification of workers; Favor PAPs by positive discrimination when hiring; Favor local populations, especially people with low incomes for unskilled jobs (local labor, cleaning, security, etc.); With equal competence, favor the youth of the locality; Create a local recruitment committee based at the commune level.	Number and type of contracts signed; % of jobs recruited locally; Number of working sessions with the IRTSS.	Environmental and social monitoring report; minutes of meeting with the IRTSS; Proof of the workers' declaration to the IRTSS.	From the start of the works and throughout the duration of the operation	Provider in charge of the works Operator of the power plant
	Preparation and construction work Operation of the power plant	Business opportunities for economic operators	Grant market shares to local companies;	Number of local companies with service contracts	Minutes of the meeting with service providers; Report on environmental and social monitoring	From the start of the works and throughout the entire operating period	Provider in charge of the works Operator of the power plant
	Operation of the power plant	Strengthening of the energy sector	Densify the electricity distribution network in the town; Study the possibilities of reducing the costs related to the electricity of the commune of Malicounda	Rate of electrification of the municipality	minutes of reception of extension works	During the operation	SENELEC

		Increase of revenues for the commune	Pay local taxes	Municipal budget	Receipt for payment	After the first year of operation	Malicounda Power

X.3.3. IMPACTS REDUCTION PLAN DURING CONSTRUCTION PHASE

Table 89 : Impacts reduction plan during the construction phase

receiving Component	Activity / source	impact	Mitigation measures	Monitoring indicators	Means of verification	Operating schedule	Manager
Air Quality and Climate	Preparatory, construction works	Modification of air quality due to: - emissions of atmospheric pollutants, greenhouse gases - the raising of dust by vehicle's engine, by trucks	● Do baseline air quality; ● reduce the speed of trucks to 30 km/h on the ramp that crosses the villages of Malicounda; ● comply with regulations in terms of pollutant emissions; ● carry out regular and complete maintenance and technical inspection of the vehicles; ● ensure a rigorous planning of work periods according to the seasons (if possible); ● comply with national and international standards in terms of GHG emissions.	● Air quality analysis results in the initial state; ● Results of SO_x, NO_X, CO measures in the construction phase;	● Air quality report in the initial state; ● Environmental monitoring report; ● Technical monitoring sheet of the vehicle.	At the start of the constructio n until the end of works	Company in charge of works
Soils, surface and underground water	Preparatory, construction works	● Modification of the local topography and destruction of the soil;	● provide a water drainage system before the rainy season; ● ensure that no vehicle maintenance is carried out on site;	● quantity and types of waste evacuated ● Results of underground water analyzes	● Monthly environmental monitoring report;	At the start of the constructio n until the end of the works	Company in charge of the works

		• Waterproofing, compaction and packing; • Pollution of the soil and surface and underground waters: -by accidental spills or leakage of chemicals -by waste generation	• limit spills and accidental leaks by providing anti-pollution kits; • store oils and other dangerous products on sealed retention tanks; • ensure that vehicles and construction equipment have a technical inspection in order; • collect solid and liquid waste according to a waste management plan; • educate and train staff on solid and liquid waste management; • Reduce the area of bare soil and reforest bare areas.	in the initial state; • Number of checked vehicle maintenance; • Reforested area.	• Waste management plan; • Waste disposal forms; • Drainage plan.		
Drinking water	Preparatory and construction works	Excessive consumption of water to the detriment of the consumption of local populations; Pressure on the resource	• Carry out a hydrogeological study to determine the exploitable aquifers, the optimal characteristics for the use of the aquifer; • approach the DGPRE and the Regional Division of Hydraulics to obtain the authorizations required for the installation of drilling; • collect and use rainwater for watering runways; • use if necessary, water tarpaulins in good condition to avoid water leaks; • educate employees on the importance of water, the need to conserve it and avoid wastage.	• Results of hydrogeologic al and geophysical studies; • Water volume consumed per day; • Number of awareness sessions carried out.	• Monthly environmental monitoring report; • Hydrogeologic al and geophysical study report of the project area.	At the start of the constructio n until the end of the works	Company in charge of the works

Fauna and Flora	Site preparation works	● loss of vegetation; ● loss of protected species (ex. baobab) ● destruction of wildlife habitats; ● disruption of the natural ecosystem and the landscape through the production of waste.	● Limit the site footprint to the strictly necessary surface; ● if necessary, use small mesh screens to prevent small animals from falling into open trenches; ● respect the administrative procedure before any action on the flora; ● avoid the accidental or voluntary introduction of exotic species during the works; ● set up an effective management system for cuttings and waste resulting from the works; ● compensate (in collaboration with the IREF) for the loss of wildlife habitats by sowing native species in a nearby area with similar ecological characteristics; ● preserve protected and commercial species as much as possible.	● Reforested area; ● success rate of green spaces; ● number of signs installed.	● Monthly environmental monitoring report; ● Minutes of the meeting with the forest service.	At the start of the constructio n until the end of the works	Company in charge of the works
Noise and vibration	Operation of site machines, equipment and trucks	Modification of the soundscape due to the noise generated by the site equipment	● Maintain the pneumatic tools, machines and equipment for maintaining the noise level generated at an acceptable value; ● perform noise measurements to quantify the sound during the work; ● ensure the rollover of certain very noisy equipment such as	● number of performed noise measurements; ● number of interviews carried out on noisy equipment.	● Noise mapping; ● Monthly environmental monitoring report.	At the start of the works until the end of the works	Company in charge of the works

			site diesel engines, compressors, etc.; ● if necessary, set up a screen wall towards places of residence.				
Landscape	Erection of a fence wall, Installation of new access roads, Installation of site lighting Preparatory works, construction of the power plant	Modification of the landscape Visual impacts	● Minimize the spaces occupied for the needs of the construction site ● rehabilitate the spaces damaged during the construction; ● avoid storing equipment outside the perimeter of the construction site; ● ensure the rehabilitation of the plant cover at the end of the works; ● install exterior lighting as discreet as possible and oriented downwards; ● set up protected and downward-oriented work and safety lighting.	● Percentage of the rehabilitated exterior surface; ● Numbers and type of lamps installed inside and outside.	● State of the exterior of the construction site; ● Environmental monitoring report	At the start of work and at the end of works	Company in charge of works
Living environment	Preparatory and construction works	Pollution and disturbance of the living environment; Production of various wastes and emissions attributable to the site construction (noise, dust and	● Collect, sort and transport the waste to authorized landfills; ● educate staff about waste management; ● avoid disposing of solid waste and discharging sewage into the environment; ● carry out regular emptying of septic tanks by an approved body; ● ensure traceability of this waste; ● water the construction site soils;	● Quantity and type of waste identified and eliminated; ● Number of staff awareness and training sessions; ● Number of performed noise measurements;	● Environmental monitoring report; ● Waste management plan; ● Site waste monitoring signs.	At the start of the works until the end of the works	Company in charge of the works

		smoke emissions, liquid discharges, packaging, etc.)	● organize the management of hazardous waste and ensure its recovery and treatment with specialized companies in the area ● carry out work that induces noise beyond rest hours;	● frequency and times of watering runways; ● number of emptying of septic tanks			
Living environment	Preparatory, construction and erection works Transport of equipment and materials	Disruption of traffic following the routing of equipment from the Dakar power plant to Malicounda, Traffic disruptions following the rotation of trucks for excavation work, of clearing of excavated material, of transport of construction materials between landfill areas and the site, Risk of accidents	● Develop a periodic traffic plan for the delivery of materials and equipment; ● use a professional escort between Dakar and the site; ● use platforms and container ships adapted to the dimensions of the equipment; ● inform the stakeholders (town halls, municipalities, populations of the date of the convoy (by radio, newspapers) on the routes, the risks, the measures to be taken to avoid accidents; ● educate the drivers and insist on speed limits to 30 km/h at the level of the Malicounda ramp between the site and the RN1; ● Put up signposts in the most dangerous places.	● Number of signs put in place on the access roads; ● type of agreement with the professional escort ● Number of training sessions; ● Type and number of communicatio n sessions with stakeholders ● Number of sensitized drivers	● Circulation plan; Service ● Service contract with professional escort ● minutes of the awareness sessions; ● Download of information release to stakeholders.	At the start of the works until the end of the works	Company in charge of the works

socio-economic	Site liberation	Loss of cultivated land; Loss of production; Loss of income; Loss of land plots.	• Request the services of the departmental commission for the census and assessment of expenditures. • Develop a PAR and implement it.	• Number of identified landowners; • number of people having withdrawn their check;	• CDREI report; • Minutes of the payment of compensation • Results of the PAR	Before the start of works	SENELEC
Health and safety of workers and populations	Preparatory, construction and erection works	• Development of dermal or respiratory diseases • Insalubrity following anarchic waste discharges • Risk of injury	• Ensure sorting site waste, its proper disposal and daily monitoring; • educate workers on the importance of maintaining site hygiene and safety; • appoint an HSE manager in the site • install toilets in the site by gender; • avoid as much as possible the use of manual handling involving risks of injury; • provide workers with PPE suitable for their workplace and require them to wear it; • provide the population and workers on the site with a medical unit for the surveillance and management of ARI; • establish a traffic plan and rules on the site; • put pictograms, beacons and prohibition and signalization signs in all risk areas	• Number of accidents recorded zero (zero tolerance); • number of population awareness sessions • number and type of PPE distributed • number of toilets installed by gender.	Monthly environmental and social monitoring report minutes of the awareness meeting	Before the start of the work	Company in charge of the works

			• carry out information and awareness campaigns for the population				

X.3.4. IMPACT REDUCTION PLAN DURING OPERATION PHASE

Table 90 : Impact reduction plan during the operation phase

Receiving component	Activity / source	Impact	Mitigation measures	Monitoring indicators	Means of verification	Implemented schedule	Responsible
Air quality and climate	Fuel oil combustion by groups of the power plant operating on diesel Transport of the staff and delivery of fuels and other inputs	Modification of the quality of air due: • to harmful pollutants (NOx, SO2, CO, PM) released during the production of electrical energy, • to pollutants resulting from the exhaust pipes of moving vehicles	• Evaluate the air quality in the area of influence of the project in the operation phase; • ensure long-term monitoring of ambient air quality in the various sites listed as potential receptors; • monitor Nox, SOx and PM air emissions; at the chimneys; • create green spaces; • reforestation campaigns;	• Results of measurements carried out on ambient air quality	• installation of diffusion tubes at dedicated locations	During the entire operation phase	Operator of the power plant

Ground, subsoil, surface water, groundwater	Operation of the power plant (Engine lubrication circuit, Transport, handling and storage of fuels);	• Pollution and contamination of soils, subsoils and groundwater by accidental spillage or leakage of oils, fuels, chemicals, purge water, wash water and other liquid effluents	• Collect water from runoff according to the various works used to contain it and control its quality before any discharge or recycling; • treat water likely to be affected by hydrocarbon; • comply with standard NS 05-061 before rejection; • use watertight retention bowls for storing chemicals; • Ensure the unloading and handling of fuel oil on fitted and waterproof surfaces; • establish intervention procedures in the event of an accidental spilling or leakage; • sort and then store the waste in a sealed area; • find approved channels for the transport, storage and disposal of waste; • perform periodic tests at regular intervals to verify the good condition of the tanks and the proper functioning of the trucks.	• Volume of liquid effluents collected and treated per day; • Volume of wastewater discharged per day; • Frequency of circuit inspection rounds; • Results of analysis carried out on wastewater before discharge.	Liquid and solid effluent management system; Monthly environmental monitoring report.	During the entire operation phase	Operator of the central
Drinking water	Operation of the power plant (cooling system, consumption of turbines,	• Excessive consumption of water to the detriment of the consumption	• Set up a rational water management policy; • educate staff on the need of not wasting water;	• Volume of water consumed per day;	• Monthly environmental monitoring report; • Display on the counter	During the entire operation phase	Operator of the power plant

	etc.), cleaning of facilities and premises, for sanitary needs, etc.	of local populations; ● Pressure on the resource	● put up signs at the toilets and washbasins to make employees and visitors aware of the importance of preserving water; ● promote preventive maintenance of pipes and water points; ● repair any damage that could cause a water leak in real time; ● set up a piezometer fitted with an automatic data recorder for better monitoring of the condition of the aquifer.	● Number of awareness sessions.	● water management registry		
Fauna and Flora	Operation of the power plant Maintenance Activities	● degradation of vegetation cover following the impact of fine particles of pollutants in the vicinity of the power plant; ● Contamination of plant species around the site; ● Invasion of the environment by exotic species;	● Respect scheduled shutdowns and implement a maintenance program for diesel groups; ● Put filters in the chimneys to purify the smoke before being released into the atmosphere; ● Ensure that no exotic species are introduced accidentally or voluntarily on site; ● Put in place devices to reduce noise and vibrations; ● Limit access to land located around the power plant to the staff to minimize disturbance of wildlife.	● Results of the ● Number of exotic species identified; ● Frequency of chimney maintenance; ● performed noise measurements ; ● number of installed anti-noise devices	● Monthly environmental monitoring report; ● noise map	During the entire operation phase	Operator of the power plant

		• Fauna disturbance					
Landscape	Presence of the power plant	• Visual impact due to the modification of the overall appearance • Visual impact due to the night lighting of the power plant	• Beautify the site by reforestation operations with local species as part of a landscaping plan; • Regularly maintain new vegetation until stabilization; • Set up a discreet security lighting system and orient it downwards;	• Nature of plants and planted areas; • number of vegetation maintenance; • number of visible chimneys.	• Monthly environmental monitoring report; • Landscaping plan.	At the start and during the entire operation phase.	Operator of the power plant
Living environment	Operation of the power plant Maintenance activities Staff transport and delivery of fuels and other inputs	• Generation of solid and liquid waste; • Dust and pollutant emissions; • Increase in traffic	• Set up a traffic plan inside and outside the site; • Put up signposts in the most dangerous places; • Train and educate drivers and insist on speed limits to 30 km/h at the Malicounda ramp between the site and the RN1; • Establish a waste management plan; • Keep a waste disposal register; • Choose a recovery of used oils, greases and centrifugation sludge in a local cement plant; • Train and educate staff on waste management;	• Type and volume of waste treated; • number of training sessions; • number of signs installed on the access roads.	• Memorandum of understanding with a local cement plant; • circulation plan; • waste management plan; • waste disposal forms; • monthly environmental monitoring report;	During the operation phase	Operator of the power plant

			• Set up a buffer zone between the power plant and the neighborhood. • Adjust the fuel trucks' supply schedules so as to avoid deliveries during peak hours in order to minimize the risk of accidents;				
Noise and vibration	Process of producing electrical energy Operation of the power plant Maintenance Activities	• Sound pollution; • Vibrations.	• Install specific equipment with a low noise level; • plan during the construction of the power plant, the use of acoustic insulation materials for containers, the control room, etc.; • equip and require workers to wear noise-canceling headphones at noisy workstations; • set up a periodic maintenance program for the noisiest equipment to keep the noise level generated at an acceptable value; • perform acoustic measurements at the property line; • assess the impact of the noise emitted by the power plant on the neighborhood and check whether the maximum noise thresholds are not exceeded.	• Sound level measurement results; • number of noise-canceling devices installed • number of distributed noise-canceling headphones.	Noise mapping; Report on maintenance frequency and condition of equipment; Monthly environmental monitoring report.	During the entire operation phase	Operator of the power plant

Health and safety of employees and the population	• Process for producing electrical energy Transportation and storage of fuel	• respiratory disorder • Trauma due to noise • fire • Risk of • injury • Unhealthiness following the anarchic waste management • Accident traffic	• Take into account the general principles of prevention in health and safety at work; • establish a reliable sanitation system; • train workers in first aid techniques; • appoint a health and safety coordinator and train a CHST; • provide workers with PPE adapted to each workstation • make workers aware of the importance of respecting the wearing of PPE and collective protection barriers; • use an ultra-low sulfur diesel (ULSD); • regularly inspect work equipment and after any accident; • identify ATEX areas and implement rigorous safety instructions; • prohibit intervention on any equipment in operation or presenting risks for maintenance or repair work; • carry out regular inspections as well as preventive maintenance of installations and equipment (storage tanks, retention tanks, etc.); • ensure the empowerment of tanker truck drivers	• Number and types of distributed PPE; • Number of awareness sessions; • Number of danger pictograms installed • Classification of dangerous areas.	• Monthly Environmental Monitoring report • Safety Manual • signs in dangerous areas	During the entire operation phase	Operator of the power plant

			● raise awareness among the population of the precautions to be taken when transporting fuel				

X.3.5 Risk Management Plan

The technological risk management plan is presented in the tables below.

Table 91 : Risk management plan

Installations or activities at risk	**Dreaded events**	**Potential risks**	**Prevention measures**	**Responsible for implementing the measures**	**Period for implementing the measures**	**Means of controlling the consequences**
Fuel unloading and storage area	Hydrocarbon leak Containment loss of the tank Fire bowl or tank Explosion of the gaseous ceiling of a tank	Pollution Thermal effects Overpressure effects Appearance of a boil-over	● strict application of stripping procedures including braking operations and setting of the vehicle ● Establishment of reliable fuel level indicator on the fuel oil tanks (heavy, light) ● Degassing of the tank and atmosphere control prior to any activity ● Fire permit during hot spot operation ● Regular control of the water level at the bottom of the tank and purge as soon as the water level is high ● Fire water tanks and well-functioning fire network	Responsible of the power plant	From the start of operation and maneuvers	● Adequate extinguishers in places, Easy access for firefighters ● Sound alarm ● Existence of IOP ● Well-trained intervention team ● Fire test and periodic IOP

Recovery boiler	Break in steam supply line	Severe burns Overpressure Projectile effects	● Temperature and pressure sensors ● Prohibition of nearby handling ● Regular control of water from the PDD ● Training and awareness of staff	Operator of the power plant	As soon as the boiler is installed	Immediate shutdown of the boiler First aid for the injured Immediate evacuation of injured
Diesel units	Loss of containment of oil tanks	Localized pollution Fire / explosion in the presence of an ignition source	● Temperature and pressure indicator with alarm ● Cooling of oil at the outlet of the tank ● Leak detection by level detection of oil in the tank	Operator of the power plant	In the group's installation phase	Adequate extinguishers in place limited access Existing IOP
	presence of unburned fuel in the combustion chamber after the flame extinction	fire / explosion Loss of the integrity of the installation	● Permanent control of combustion parameters (flame, temperature, flow air, etc.) ● very strict operation procedure ● control of the air supply in the combustion chamber			
transformer	● short circuit on the transformer ● Loss of the oil storage containment	● fire / explosion	● regular control of protections ● Protection against lightning ● Grounding ● Oil level indicator			● Automatic electrical isolation device of the transformer in case of malfunction ● Automatic leak detection ● Oil drainage to a hydrocarbon separator

Demineralization station and effluents' treatment system	• Loss of containment of a demineralization cell	• Pollution • Skin contact with the operator	• appropriate building materials and proven for the regeneration phases • preventive inspection and maintenance of equipment • no handling near the demineralization area	Operator of the power plant	Installation period of the position and during the operation	• bowl retention • Procedure of handling chemicals • Operational procedure for regenerating of demineralization cells
	Overflowing the effluent treatment unit (emulsion, oil, diesel, fuel oil, etc.)	• Leakage of contaminated emulsion / liquid • Soil pollution	• Preventive inspection and maintenance of equipment • Sensors of the tank level • Compliance with operating instructions	Operator of the power plant	Installation period of the position and during the operation	Automatic leak/overflow detection Immediate shutdown of the transfer pump to another point of settling Construction of secondary buffers related to main skimmer Construction of a buffer between the skimmer and the final outlet Regular drain
Traffic and fuel supply	Accident	Spill of hydrocarbon and soil pollution Fire of the hydrocarbon slick on the ground Domino effect possibility	• Training of the staff • Empowerment of the transporters • Daily review of tank trucks • Well-defined delivery circuit • Put danger pictograms on trucks • Provide the SDS of the transported products	Operator of the power plant	From the project design	• Trigger of the IOP • Call emergency • Ensure the driver's awareness

X.4. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN AND PROCEDURES

The application of the plans and procedures below allow proper consideration of environmental and socio-economic aspects within the framework of this project.

X.4.1. LAND ACQUISITION PROCEDURE

The 18-ha allocated to SENELEC within the framework of this project were obtained by deliberation of the Municipal Council of Malicounda. Initially, 15 ha were sold following the deliberation no. 02/CRM of 27/01/2012. The remaining 03 ha were obtained on June 13th 2018 following another deliberation by the municipal council of the commune.

During this phase of land acquisition, SENELEC will have to identify the owners of the land and other properties located in the site right-of-way and that are likely to be damaged.

The regulatory provisions to be respected within the framework of this operation are related to:

- Decree No. 72 - 1288 of October 27th 1972 setting the conditions for the allocation and decommissioning of land in the national domain located in regional areas;
- Decree No. 88 - 074 of January 18th 1988 repealing and replacing decree No. 85 - 906 of August 28th 1985 relating to the price scales of bare land and built land applicable in terms of rent and expropriation for reasons of public utility;
- Decree 91-838 of August 22nd 1991 allowing all residents to be compensated.

The work of an operational group under the leadership of the Governor of Thies Region is the formula recommended within the framework of this type of project, not only to assess the losses suffered, but also to ensure reconciliation between the project and the affected people.

To secure the land, SENELEC after delimiting the right-of-way materialized by a boundary wall or barbed wire must approach the competent services for a final land acquisition. In this endeavor, a request for registration of the land was made at the level of the Domains management.

X.4.2. INVOLUNTARY RESETTLEMENT ACTION PLAN

The analysis of the immediate environment of the site allows to highlight the existence of very close dwellings near the site of the power plant. These are homes in Keur Maissa Faye district in the village of Malicounda Wolof. Furthermore, the district of Malicounda Ngueurigne is located at 362 m from the power plant.

All the dwellings located within the security perimeter should be relocated, hence the relevance of implementing an involuntary resettlement action plan to relocate them.

This PAR will take into account all occupations located within the danger radius (260m) defined through the conclusions of the EDD. A preliminary census will be made in order to identify all the PAPs and to assess the nature and amount of the losses they will have to suffer. The PAR start-up report is currently available and provides the basis for determining eligible persons, vulnerable groups, complaints management procedure, etc.

X.4.3. LIVELIHOOD RESTORATION PLAN

The release of the land base by the former owners has resulted in a loss of cropland and therefore a loss of production and income.

A strong recommendation of the study following public consultations is to set up a Livelihoods Restoration Plan (PRMS) that will effectively compensate for the losses of activities suffered by the populations with the advent of the project.

X.4.4. WATER RESOURCES MANAGEMENT PROCEDURE

The management of groundwater resources must be done by:

- setting up a monitoring system with adequate indicators by installing piezometers fitted with an automatic data recorder that will allow to monitor the level and quality of the water aquifer;
- measuring of parameters related to the products used on site, particularly fuels and chemicals.

X.4.5. WASTE MANAGEMENT PROCEDURE

Optimal management of waste generated and products and equipment out of service will limit their impact on the environment.

The sorting of waste will be done according to its nature and its dangerousness and will make it possible to:

- separate hazardous waste from non-hazardous waste;
- separate recoverable waste from non-recoverable waste;
- monitor the production volume by type of waste;
- keep a waste production register;
- collect, transport and dispose of waste by a specialized body in accordance with national legislation.

The HSE team will set up an evacuation slip which will keep the waste register up to date.

Recoverable waste must be collected by local companies, recognized after verification of their final destination.

X.4.6. TRANSPORTATION MANAGEMENT PROCEDURE

When loading and transporting the components of the power plant, from the place of disembarkation to the place of operation, impacts may occur on the circuit.

It is necessary to know the dimensions of the equipment in order to set up adequate safety devices for their transport and thus to inform Ageroute before the arrival of the equipment.

During the operation phase, the supply of fuel will lead to an increase in traffic. It is therefore strongly recommended to set up an internal and external circulation plan at the site.

X.4.7. INTERVENTION PROCEDURE IN CASE OF SPILL

All containers must be placed under retention to avoid all forms of soil and water pollution. It is also recommended to provide anti-pollution kits such as absorbent paper and to have, next to the storage areas, tanks for collecting spilled products.

It should be noted that the training of agents assigned to the handling of polluting products is necessary for the control of the risks related to the exposure to these products.

X.4.8. ACCIDENTS PREVENTION PLAN

In order to limit the number of accidents occurring during the construction and operation phases, a risk study must be carried out for each workstation. This will determine the risks inherent in the work carried out as well as the individual and collective protection equipment to limit the risk of accidents.

The necessary awareness and training regarding the risk levels associated with the work to be carried out must be provided by the proponent or by an approved body.

The study recommends that only workers trained and equipped with their PPE should carry out the work within the framework of this project. Workers must be penalized in case of non-compliance with health, safety and environmental hygiene measures. Monitoring the applicability of this rule is the responsibility of the company responsible for operating the power plant.

X.4.9. MANAGEMENT PLAN FOR HAZARDOUS MATERIAL

For good management of hazardous materials, it is essential to make an inventory of hazardous materials, record flows and identify exposed personnel.

It is also imperative to write a procedure for managing hazardous materials in order to be able to establish safe working methods and techniques.

The purchase of hazardous materials requires special attention from the site operator. In fact, a prudent purchase will save time and money, by reducing storage requirements, avoiding excess stocks and eliminating the disposal of obsolete materials and hazardous waste. The operator must avoid using chemicals and hazardous materials that are internationally prohibited or subject to a phase-out procedure.

X.4.10. MANAGEMENT AND GRIEVANCE MONITORING PROCEDURE

At all stages of the project (construction and operation), it is imperative to develop a grievance settlement procedure that will allow the entire concerned population, through possible nuisance resulting from the activities of SENELEC or the operator of the power plant, to bring up to the level of the project team the problems encountered on a daily basis. The most recurrent complaints concern:

- noise and / or dust near construction site activities and on the route of delivery trucks;
- complaints relating to non-compliance with the commitments initially made.

Three (03) systems will be put in place to allow grievances to go back to the project proponent:

- the opening of a grievance book at the entrance to the construction site, where complainants can register their complaints. This document will be read each week by the manager of the social section for possible processing;
- the provision of a book of complaints at the level of the Town Hall of Malicounda in order to collect complaints;
- the identification of problems made during regular site visits by the control mission;

The complaints registered and the solutions brought will be presented in a monthly activity report of the company to be validated by the proponent who is in charge of the mission of control and surveillance of the project.

The results will be communicated to the complainants (by posting in the villages, town hall, construction site and/or direct communication).

X.4.11. INFORMATION AND COMMUNICATION WITH PUBLIC PROCEDURE

The execution of the project work can cause inconvenience such as: traffic obstructions, security or health risks, etc.

As a result, an information and awareness campaign among the populations living near the site becomes a necessity. In fact, this information campaign will, among other things, make it possible to:

- raise awareness of the benefits of the project;
- allow the acceptance of this project by the populations;
- sensitize the populations on the schedule for the release of works;
- raise awareness of the security measures to be taken during all phases of the project;
- educate and train site workers and ad hoc teams in rapid response techniques in case of an accident;
- define a security perimeter around the site.

Information and communication to the public must be done systematically at the start of the two major phases of the project (construction and operation). However, the frequency of these awareness and information campaigns during construction as well as during operation is left to the discretion of the site HSE manager. The latter has as barometers the receptivity of its targets (workers and population), the rate of application of the instructions issued, the frequency of complaints, the change of staff or work process, the transition from one phase of work to the other, etc. He must therefore prepare a good communication plan with the populations in order to easily transmit his message.

X.4.12. INFORMATION AND COMMUNICATION WITH STAFF AND SUPPLIERS PROCEDURE

During the construction phase, the study recommends the implementation of information and communication measures with service provider staff, in particular on training in HSE questions. This information campaign should cover:

- waste management methods, hazardous products and emergency procedures in case of spills;
- environmental awareness regarding the reception area and local populations;
- the environmental and social risks associated with the project as well as the mitigation measures implemented under the ESMP;

The personnel of the service provider must be sensitized and trained periodically in order to maintain a high level of knowledge in terms of HSE.

X.4.13. PERIODIC AUDITS AND ESMP REVIEW PROCEDURE

The environmental monitoring recommended by the ESMP is the responsibility of the Project which, after obtaining the certificate of compliance, is under the obligation to regularly submit a report of its monitoring activities. The monitoring committee will have to rely on this report to ensure environmental monitoring.

The audit and the review of the ESMP will depend on the effectiveness of the proposed measures and major changes in the project or in its immediate environment (evolution of techniques, evolution of the living environment of the host area, new IC near the site, etc.).

Due to the absence of regulations on this aspect, the Project could draw inspiration from good practices in this area for the review of the ESMP. However, it should be noted that during the operation phase of the project an Environmental Management System (EMS) will be put in place to take care of all environmental and social aspects.

X.4.14. PROCEDURE RELATED TO CHANCE DISCOVERY

This procedure aims to protect the cultural/religious heritage of the project area.

It applies to all personnel during the construction and operation of the power plant. The procedure is implemented by the EPC and O&M, managers of the power plant. In case of a chance discovery on the site, the manager must be alerted. The latter will be in charge of contacting the Mayor of Malicounda, the Sub-prefect of Sindia and the Prefect of Mbour. Thus, all work will be immediately suspended, pending the measures to be dictated by the authorities. All stakeholders will need to be made aware of these issues as part of the HSE process and the information should be shared with all employees.

X.4.15. CLOSURE AND RESTORATION OF THE SITE AFTER OPERATION PLAN

In case of cessation of operation or abandonment of the project, the owner must dismantle the installations, demolish the buildings and evacuate all types of waste generated.

The power plant dismantling at the end-of-life will be in accordance with the regulations in force. Equipment from electrical installations can be recycled according to their materials.

Noted that the obligation to restore the site is related exclusively to the operator and that the redevelopment of the site is deemed necessary for the enhancement of the space. The site will be returned to the state it was in before the installation (suitable for agriculture).

The socio-professional reintegration of workers must also be taken into account by the promoter.

X.5. ENVIRONMENTAL SURVEILLANCE AND MONITORING PLAN

X.5.1. ENVIRONMENTAL MONITORING

Environmental monitoring is the operation that allows the application of the mitigation measures developed in the ESMP and compliance with environmental laws and regulations. Environmental monitoring is the responsibility of the Project. The latter sends reports, the frequency of which depends on the company's ranking. For thermal power plants classified in Annex I, the reports must be sent to DEEC every three (03) months.

Noted that these reports and all activities relating to environmental management will be carried out under the supervision of an HSE manager recruited for this purpose.

Table 92 : Overview of surveillance measures

Concerned component	Recommended measures	Period	Cost[17] in F CFA	Responsible
Air quality	Make noise and dust measurements at the site	During works	6,000,000 (Equipment acquisition)	MP
	Set speed limits on the access road from the start of the construction phase	Before the start of work	For memory	Company in charge of works
	Monitor each chimney during the entire operational phase	Operation phase once a month	6,500,000 (Equipment acquisition)	MP
	Make continuous measurements of the ambient air quality (SO2, NOX) for 10 points around the site via passive tubes	Operation phase (monthly)	4 500 000 per year	MP
	Make ambient air quality measurements (SOx, NOx, CO, PM, VOC) for at least 10 points around the site before the start of the construction phase	Operation phase once a month	5 000 000	MP
Noise	Make measurements of the ambient noise level before starting work	Quarterly operating phase	For memory	MP
	Monitor the noise level in the work area	Quarterly operating phase	For memory	MP
Surface and groundwater	Set up a piezometer equipped with an automatic data recorder for monitoring the aquifer	Construction phase	For memory	MP
	Provide drainage channels for rainwater and wastewater from the start of the work	Construction phase	For memory	MP

[17] This cost is indicative and serves as the basis for knowing the expenses to be made in the context of the environmental and social management of the project

Concerned component	Recommended measures	Period	Cost[17] in F CFA	Responsible
	Perform hydrogeological studies to confirm the availability of water (necessary for drilling)	Before the start of works	For memory	MP
Fauna and Flora	Apply the convention between SENELEC and Water and Forests on forest taxes to obtain the tree felling permit	Before the start of works	For memory	SENELEC/MP
	Put a green belt along the boundaries of the power plant (convention with the water and forest service)	Construction phase	For memory	SENELEC/MP
Living environment	Set up a stakeholder engagement plan before the start of the construction phase (Communication and information dissemination plan to stakeholders)	Before the start of work and during the construction and operation phases	Cost integrated into the operating budget	SENELEC/MP
	Establish a grievance mechanism before the start of the construction phase	Before the start of work and during the construction and operation phases	Cost integrated into the operating budget	SENELEC/MP
	Coordinate with the Municipality to agree on the collection and disposal of non-hazardous waste	Before the start of works	For memory	MP
	Contract with an approved service provider for the collection and disposal of hazardous waste	In operation phase	For memory	MP
	Set up a local recruitment committee to promote local employment (by covering the organization and logistics costs of the committee)	Before the start of works	200,000 per session (with an average of 5 sessions per year)	MP / SENELEC / Local authorities

Concerned component	Recommended measures	Period	Cost[17] in F CFA	Responsible
Socio-economic impact	Carry out an action plan to resettle the PAPs (if necessary)	Before the start of works	40 000 000	SENELEC/CDREI
	Execute the PAR	Before the start of works	To be evaluated in the PAR	SENELEC/CDREI
Environmental and social management	Set up an internal HSE management system with a dedicated team	Exploitation phase	Cost integrated into operations	MP
	Recruit an HSE Consultant to supervise the work and implement stakeholder engagement plans and the grievance mechanism	Exploitation phase	Cost integrated into operations	MP
	Build the capacity of DEEC with training in environmental and social management of thermal power plants (See paragraphs X.5.2 and X.6)	Exploitation phase	20,000,000 single grant	MP
	Provide an annual budget for the operation of the environmental and social monitoring and follow-up committee, led by the Department of the Environment and classified establishments (See paragraphs X.5.2 and X.6)	Construction and operation phase	3,000,000 (construction phase) 1,500,000 per year (operational phase)	MP

X.5.2. ENVIRONMENTAL MONITORING

Environmental monitoring is the control over time and space of the mitigation measures proposed in the study. Indeed, it describes the measures planned by the ESMP in order to verify on the ground the correctness of the assessment of certain impacts and the effectiveness of certain mitigation or compensation measures.

Monitoring is carried out by state authorities such as DEEC and the competent technical services.

Table 93 : Environmental monitoring elements

Aspect	Type and location of monitoring	Method / Indicators to follow	Periodicity	Date of implementation
Means od Subsistence of PAPs	Monitoring of PAPs at the level of local populations	Development of restitution plan for means of subsistence and support measures for PAPs	To be determined in the PAR	Before starting work
Air quality Emissions	NOx, SO2, CO, O2 concentration measurements at chimneys	By portable analyzer by an approved company Difference between the measurement results and the ELVs of Standard NS 05-062; Corrective measures taken.	Annual	Upon commissioning
Air quality Emissions	NOx, SO2 concentration measurements in the ambient air around the power plant, at the property line and according to the prevailing winds	Concentration measurements by diffusion tubes Difference between the measurement results and the ELVs of Standard NS 05-062; Corrective measures taken.	Every 6 months, in collaboration with the laboratory of the Air Quality Management Center	Before commissioning and during operation
Quality of wastewater discharged	Sampling at the discharge points	Measurement of plant wastewater parameters (pH, MEST, BOD5, COD, Total nitrogen, Total phosphorus, Total hydrocarbons, etc.);	Every 6 months	From the start of operations

Aspect	Type and location of monitoring	Method / Indicators to follow	Periodicity	Date of implementation
		Difference between the measurement results and the ELVs of Standard NS 05-061.		
Groundwater quality	Sampling from the drilling of the power plant and a piezometer	Periodic analyzes of the physio-chemical characteristics of water; Deviations from the potability standard.	Every six months	From the date of commissioning
Water consumption	Installation of meters and flow meters at the borehole pumps	Monitoring the productivity of the aquifer and assessing the behavior of the aquifer level; Control of overconsumption.	Every month in collaboration with the DGPRE	From the date of commissioning
noise	Sound power level of power plant machines (diesel engines, turbo-compressors, air compressors, etc.)	Noise measurements performed by a class 1 integrating sound level meter; Noise mapping; Number of anti-noise devices installed.	Every six months	From the date of commissioning of the power plant
	Noise level at the property limits of the power plant	Noise measurements performed by a class 1 integrating sound level meter; Noise mapping; Number of anti-noise devices installed.	Every six months	At the start of the operation phase

X.6. INSTITUTIONAL CAPACITIES RE-ENHANCEMENT PLANT

For the proper execution of the measures contained in the ESMP and the monitoring of their application, it must be taken into consideration that the technical capacities for implementing the various negative impact mitigation and monitoring measures are not the same for all categories of stakeholders. Therefore, to allow all stakeholders to play their role, it is imperative to enhance their capacity on environmental issues related to the project. Thus, to take proper account of environmental and social issues during the execution of the activities provided in each component in accordance with the ESMP, the operator will have to develop a capacity-enhancement program for external structures (State technical services, Local authorities, CRSE, etc.) involved in monitoring the implementation of the ESMP.

This capacity enhancement program should be based on training campaigns on:

- HSE management of an energy project;
- HSE best practices for the construction and operation of a power plant;
- the mitigation measures to be implemented;
- etc.

This training program will be conducted by SENELEC and Malicounda Power with the support of an HSE specialist. To do this, a budget of 20 million must be made available to the members of the monitoring committee, under the coordination of DEEC.
In addition to this training, this budget may support DEEC and DREEC with the following:

- Logistics assistance:
  - O 5,000 liters of fuel in the construction phase
  - O 1000 liters of fuel per year in the operating phase
- IT assistance:
- in the construction phase:
  - 5 laptops
  - 2 printers
- in the operating phase
  - 10 reams of paper per year
  -10 ink cartridges per year.

X.7. ESMP IMPLEMENTATION PLAN

X.7.1. RESPONSABILITIES

Responsibility for the implementation of the measures recommended in the ESMP is shared between the project promoter, the contractor, and if required the operator of the power plant and other stakeholders in the field.

- **PROJECT PROMOTER**

In all stages of the project, the promoter is the first supervisor of the implementation of the measures. He must ensure strict compliance with environmental and social issues by those responsible for carrying out the project.

In the operating phase, he must appoint an HSE manager who will be responsible for ensuring regulatory compliance with hygiene, health and safety in the plant as well as waste management

- **CONTRACTING COMPANY OF THE PROJECT**

The company in charge of the work will be obliged to comply with the clauses of the Market Contract and the Notice of Environmental and Social Clauses which will be sent to it.

Compliance with these practices will condition in particular the final acceptance of the site and the payment of the related financial maturity if provided.

- **PLANNING AND MONITORING OFFICE**

The strategy recommended for the successful implementation of support measures is based on their monitoring by a planning and monitoring office, under the supervision of SENELEC in collaboration with the relevant state departments (DEEC, DREEC, IREF, IRTSS, etc..). This approach takes into account the circumstances prevailing at the time of the implementation of the measures recommended in the ESMP. The planning and monitoring office recruited for the execution of certain project support actions must comply with the terms of reference drawn up by the promoter for the actions to be carried out.

- **DEEC, DREEC AND THE MONITORING COMMITTEE**

State responsibility for controlling the environmental management of the project is officially entrusted to DEEC through the Environmental Impact Assessment Division (DEIE). In principle, copies of monthly environmental activities and monitoring reports should be sent to DEEC, which is the body responsible for monitoring environmental compliance of projects. Organizations such as NGOs, associations and local SMEs may also be called upon as neutral actors in the monitoring and evaluation of the ESMP.

The committee will be composed of the following members, without limitation:

- the administrative authorities (the Governor and the Prefect);
- local authorities;
- representatives of the populations;
- the Directorate of Environment and Classified Establishments (DEEC);
- the relevant State Technical Services;
- the HSE Consulting Engineering Office;
- relevant stakeholders (NGOs, representatives of women's groups; representatives of young people,);
- representatives of the Ministries of Industry, Interior, etc.

The committee will be supported technically and financially by the promoter and its partners for effective monitoring of the management plan. It will meet periodically to assess experts' reports on the company's environmental, hygienic and safety monitoring. Therefore, the committee will issue recommendations to be applied.

X.7.2. OPERATIONAL MEANS AND PROCEDURES

To confirm its willingness to take into account the environment, the company will be required to:

- to recruit / designate one (or more) competent manager (s) responsible for managing the environmental aspects as well as the HSS aspects;
- to draw up an Environmental and Social Action Plan for the site, highlighting in particular the conditions for the treatment of solid and liquid discharges from construction sites and equipment, conditions for restoring work sites, conditions for vehicle traffic and construction machineries, current regulatory constraints, and / or commitments made with third parties;
- to integrate into the Environmental and Social Action a Hygiene, Health and Safety Plan which it will undertake to respect for work likely to produce impacts, namely: pollution of the environment by debris, pollution noise (noise of machines), risk of accidents, disruption of the movement of goods and people;

- comply with national regulations on workers' health and safety and comply with ILO conventions and the fight against STDs.
-

X.7.3. IMPLEMENTATION DEADLINES

Monitoring and follow-up of the project will take place during its entire lifetime. They will begin at the start of construction.

During the years of operation, the activities supervised by the promoter will be subject to evaluation and follow-up reports and sent regularly to DEEC, in accordance with legislation.

X.7.4. COST ESTIMATION

The overall cost of environmental monitoring of the project during the construction and operation phase is estimated at 45,000,000 FCFA. This budget includes the purchase of supervision equipment (sound level meter, calibrator, test for chimney emissions, etc.).

Noted that this budget may be updated and reassessed as the project progresses. The table below help to put a budget for the monitoring committee.

Table 94 : Operating budget of the monitoring committee

<table>
<tr><th rowspan="3">Operating budget of the environmental monitoring committee</th><th>Activities</th><th>Periodicity</th><th>Actors</th><th>Price</th></tr>
<tr><td rowspan="2">Monitoring of the implementation of the ESMP</td><td rowspan="2">Quarterly in construction phase
Semi-annual in operating phase</td><td rowspan="2">Committee members</td><td>Thiès-Malicounda-Thiès
10 000FCFA / J / Person
15 000FCFA / vehicle / fuel package</td></tr>
<tr><td>Dakar –Malicounda-Dakar
10 000FCFA / J / Person
25 000FCFA / vehicle / fuel package</td></tr>
</table>

XI. CONCLUSION

The ESIA of the project to build and operate a 120 MW thermal power plant in Malicounda has highlighted major positive impacts linked to access to populations for basic energy services and the reduction of the electrical production deficit in the interconnected network. The enhancement of these positive impacts will enable promoters (SENELEC and the project company) and the local communities concerned **to promote the energy components of the PES**, but above all to promote new jobs and create income in the area of implementation.

However, the project could present medium to major impacts and risks due to:

- loss of land, production and income for the current occupants of the site;
- displacement of populations located within the security perimeter (radius of 260 m around the power plant);
- atmospheric releases associated with the combustion of HFO;
- hazardous waste and noise emissions;
- technological risks associated with the transport, handling and storage of dangerous products.

The development of a Reinstallation Action Plan (PAR) is inevitable within the framework of this project as the analysis of the area of indirect influence makes it possible to highlight the presence of human settlements in the security perimeter (Keur Maissa Faye district of the village of Malicounda Wolof). Consequently, the Departmental Commission of Census and Evaluation of the Expenses (CDREI) presided by the Prefect of the Department of Mbour and composed of the Technical Services of the State (STE), the Municipality of Malicounda and representatives of the PAPs was mobilized. To this end, a meeting was held at the Prefecture of Mbour in June 2018 for the start of PAR activities to liberate the area of the site.

The CDREI will be responsible for the assessment of the costs, the fair and equitable compensation of the PAPs and the liberation of the site. It will also be responsible for validating the compensation rate by referring to good practices in force in the project area and will not be based solely on the national scale.

Furthermore, the study recommends the development of a restitution plan for means of subsistence and support measures for PAPs who have suffered a loss of production and therefore income but also, a loss of plots.

The management of the different effluents generated by the power plant during the construction and operation phases is a fundamental aspect, the consideration of which has led to the following conclusions:

- the water treatment system must be well dimensioned and its performance proven;
- the operator must take all measures to keep SO2 emissions below the ELV of the Senegalese standard by using a fuel oil with a low sulfur content. The same will apply to other air pollutants;
- an efficient waste management plan will be drawn up to develop waste minimization procedures, reduce their generation and increase their reuse and recycling rate while ensuring the elimination of ultimate waste to approved channels.

The study finally recommends considering the results of the study on the initial sound environment which reveals an unpolluted type sound environment in the initial state and taking into consideration all the provisions necessary for a sound environment below the limits authorized by the regulations in force.