ESIA Summary

<table>
<thead>
<tr>
<th>Project Title: Kainji and Jebba Hydro Power Plant Rehabilitation Project</th>
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<tr>
<td>Country: Nigeria</td>
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<tr>
<td>Date of Submission: 14/10/2016</td>
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<tr>
<td>Project Task Manager: A. Chiromo, O. Amu, C. Otonglo, F. Balderamma</td>
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1. **INTRODUCTION**

This document is a non-technical summary report of the Environmental and Social Impact Assessment (ESIA) for the rehabilitation of Kainji and Jebba hydro power plants (HPP) in Nigeria prepared by Mainstream Energy Solutions (Mainstream). Both hydro plants are located in the Niger River in Niger State in north-central Nigeria.

The Kainji hydro power plant (Kainji HPP) was constructed in 1968. The Kainji HPP dam creates a reservoir 136km long, holding approximately 15 billion m³ of water. The main dam is 550m long with a height of 64m. It comprises the water intakes, the flood evacuator and the abutments. The powerhouse is located downstream of the dam, on the right side of the river bank and has an installed capacity of 760MW comprised of eight turbine-alternator groups that include four Kaplan type 80MW, two turbines also Kaplan type rated 100MW and two propeller turbines rated at 120MW. In the original design there was a provision to further accommodate four turbines, but this has not materialised. The Jebba hydro power plant (Jebba HPP), constructed 1983, is located approximately 100km downstream from Kainji HPP on the border of Kwara and Niger States. It creates a reservoir approximately 25% of the size of Kainji HPP. The dam is equipped with a spillway and a powerhouse with water inlet. The powerhouse is equipped with six turbines with a 96.4MW capacity each resulting in a total installed power of 578MW.

Currently, the available capacity of the plants is substantially below their installed capacity, due to poorly functioning equipment. The proposed Project involves the rehabilitation of the two plants, comprising engineering works associated with the replacement of turbines. The rehabilitation will be done within the existing infrastructure.

Mainstream Energy Solutions Ltd (MESL) is the project proponent for the proposed KainjiHPP and JebbaHPP rehabilitation works. MESL became a successor company to the Power Holding Company of Nigeria (PHCN) and assumed responsibility for the management of the two hydropower facilities with the objectives of stable and sustainable energy production. Electricity generation licences for the two plants were granted to MESL on 1 October 2013. Operational entities are (i) Kainji Hydroelectric Company PLC (KHEPLC); and (ii) Jebba Hydroelectric Company PLC (JHEPLC). The Concession Agreement signed between MESL and the Government of Nigeria provides rehabilitation targets for MESL to restore and extend the rated capacities and operate the plants for the next twenty (20) years without further major rehabilitation works, as well as develop and maintain the generation stations.

MESL has initiated the KHPP and JHPP Rehabilitation Project to re-establish the rated power outputs of the hydropower plants, which is required to improve electricity generation in Nigeria. To ensure that the rehabilitation works comply with international sustainable standards and guideline, MESL has
undertaken a full Environmental and Social Impact Assessment (ESIA) for the Project. In addition to meeting the national environmental regulatory requirements, the ESIA also complies with international standards such as the World Bank and African Development Bank. The ESIA study report is a consolidated output of various sectoral studies and field consultation that had taken place over the years (2012 – 2016). These studies and consultations have identified and assessed a range of key potential environmental and social impacts associated with the proposed KHPP and JHPP rehabilitation works.

The ESIA describes the Project design and the potential impacts they may have on the physical and biological environments and on people. It also addresses the measures that the Project will implement to reduce adverse impacts and to enhance potential social benefits, and how environmental and social issues will be managed during rehabilitation and operations, taking into account the imperative for compliance with applicable safeguard policies of the Bank. The contents of the ESIA includes: (i) Policy Legal and Administrative framework; (ii) Project description and justification; (iii) Description of the Project Environment; (iv) Proposed Project Alternatives; (v) Potential Impacts; (vi) Mitigation Measures that will reduce identified impacts to very minimal level, if implemented; (vii) Expected Residual Effects; (viii) Monitoring Programme; (ix) Public Consultations; (x) Summary of Environmental & Social Management and Monitoring Plans, and (xi) many Appendices of various studies.

2. POLICY LEGAL AND ADMINISTRATIVE FRAMEWORK

Federal Environmental Management Institutional Framework

The Federal Environment Management Framework is the basis for environmental policy in Nigeria and is found in Section 20 of the 1999 Constitution of the Federal Republic of Nigeria. This section provides for the protection and improvement of the environment and safe guarding of water, air, land, forests and wildlife. The Federal Ministry of Environment (FMEnv) and the National Environmental Standards and Regulations Enforcement Agency (NESREA) are the agencies responsible for enforcing compliance with all environmental standards, rules, laws, policies and guidelines for the industrial sector. They have responsibility for the development of biodiversity conservation and sustainable development programs, and coordination and liaisons with relevant stakeholders within and outside of Nigeria on matters pertaining to environmental policies, regulations, laws and standards.

The ESIA process for the proposed rehabilitation of KHPP and JHPP and ancillary infrastructure has been undertaken in accordance with the requirements of all relevant Nigerian legislation including inter alia, those of:

i. Environmental Impact Assessment (EIA) Act No 86 of 1992, which restricts public or private development projects without prior consideration of the environmental impact.

ii. National Environmental Standards and Regulations Enforcement Agency (NESREA) Act (2007), which empowers the Agency to enforce all national environmental laws and regulations (except those related to the oil and gas sector) and international treaties or conventions to which Nigeria is signatory. The Agency has issued 24 environmental regulations, which prescribe pollution abatement measures, limits and other safeguards for various industries and for noise, surface and ground water discharges among others. These regulations include (i) National Environmental (Wetlands, River Banks and Lake Shores Protection) Regulations (2009); and (ii) National Environmental (Watershed, Hilly, Mountainous and Catchment Areas) Regulations (2009) which have direct bearing on the proposed project;
iii. **National Electrical Power Reform Electric Power Sector Reform Act (2005),** which established the National Electricity Regulation Commission (NERC) and requires all entities intending to generate, transmit and or distribute power to include an EIA Approval Certificate, or Proof of submission and acceptance for processing of the Report on EIA to the Ministry of Environment in their applications;

iv. **National Policy on the Environment,** with the goal of achieving sustainable development for the country and emphasis on (a) securing for all Nigerians a quality environment adequate for their health and well-being; (b) conserving and using the environment and natural resources for the benefit of present and future generations; and (c) restoring, maintaining and enhancing ecosystems and ecological processes essential for the functioning of the biosphere and for the preservation of biological diversity and to adopt the principle of optimum sustainable yield in the use of living natural resources and ecosystems.

v. **Land Use Act (1978),** which recognizes the rights of all Nigerians to use and enjoy land and the natural fruits thereof in sufficient quality to enable them to provide for the sustenance of themselves and their families.

vi. **Other laws** – include Kainji Lake National Park Act (1979); River Basins Development Authority Act (1979 & 1986);

### International Guidelines and Standards

Relevant international conventions to which Nigeria is a signatory include:

- The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh in 2001, and are called the “Marrakesh Accords.” It is an international agreement linked to the UNFCC. Its three mechanisms are (a) Emissions trading (carbon market), (b) clean development mechanism (CDM) and joint implementation (JI).

### African Development Bank ISS Policy and Standards

This report is prepared in accordance with African Development Bank (AfDB) guidelines, in particular ESIA guidelines on environmental and social safeguards. The Operational Safeguards (OS) have been considered in the development of this document and will be applied throughout project implementation.

The Dam rehabilitation works are considered high risk activities and the power generation out of the Dam exceeds the Bank threshold of 30MW hence Operational Safeguards (OS) 1 on Environmental Assessment is triggered. However, since the rehabilitation work will not involve displacement of communities OS(2) on Involuntary Resettlement is not of concern. There is also no likelihood of significant disturbance to the aquatic life downstream of the dam hence OS(3) on Biodiversity is not of much concern. OS(4) on Pollution Prevention and Hazardous Substances is effectively considered since construction will refurbishing/replacement of turbines and associated infrastructure during the rehabilitation involve use of fuels and possibly some hazardous materials in the sensitive environment.
around the dams. OS(5) on Labour, Working Conditions, Occupational Health and Safety is of relevance since the construction will involve a significant number of construction workers.

The climate screening scorecard for the project indicated that it is a Category 1 project according to the AfDB’s Climate Safeguards System. However, although the main sources of water available for the Kainji and Jebba hydroelectric power plants are in the Sudan-Sahel zone of West Africa that are subjected to climate change induced periodic droughts and other extreme weather events, hydrologists at MESL confirmed that hydrologic modelling of the water resources in the basins indicates that the two plants will at no time be seriously hampered by shortage of water in periods of climatic variations. For example, the 1985 severe drought in the basin, which has a return period of about 100 years, did not result in acute water shortage in the catchment area and energy generation was not badly affected. The optimization of water resources for the operation and management of the two plants will be emphasized for sustainable water resources management. The need for a specific climate change action plan for the project’s basins during the operations of the HPP will be informed by a detailed evaluation of climate change risks and adaptation measures. Comprehensive, practical risk management and adaptation measures are to be integrated into the project design and implementation plans.

World Bank and IFC Principles

World Bank and IFC’s approach to the environmental and social impact of dams are set out in a series of operational papers and guidance notes. Specific guidelines include the IFC’s Environmental, Health and Safety Guidelines for Hazardous Material Management, which is contained in their General EHS Guidelines.

Other International Guidelines and Standards

Other relevant international guidelines and standards include:


3. PROJECT DESCRIPTION AND JUSTIFICATION

Kainji Dam

The dam comprises of the main concrete gravity dam with earth embanked dams on either side of the main and saddle dams, which closes a secondary valley, and two gates. The main dam is 550m long with a maximum height of 64m. It comprises of water intakes, spillway and abutments. The powerhouse is
located downstream of the dam, on the right bank, and at right angles to the water intakes. The reservoir, which forms Lake Kainji, is 136 km long and has a capacity of 15 BCM (Billion cubic metres). Kainji powerhouse is equipped with eight turbine-alternator units including four Kaplan turbines rated at 80 MW each, a further two Kaplan turbines rated at 100 MW each, and two propeller turbines rated at 120 MW each. The available head ranges between 23.8 m and 41.2 m according to the water level in the reservoir.

A schematic layout of the dam is shown in Figure 1

![Figure 1: Kainji Dam Site Plan](image)

The original Kainji HPP project considered 12 turbine units, however only eight units have been installed. The required civil structure is in place for the remaining 4 units. The project has multiple purposes, which include energy generation, flood control and navigation. The design capacity of the power station is 750 MW.

The dam has operated for approximately 45 years and wear and tear (cavitation pitting, slight abrasion, other small damages to blades and wicket gates, surface condition, etc.) has reduced the effective efficiency of the turbine by approximately 2.0% compared to the efficiency level of the ‘as built’ condition, which gives an estimated current turbine efficiency of approximately 91.3%. The aim of the rehabilitation is to re-establish the rated power output of 750MW of the hydropower scheme of Kainji until the end of November 2018.

Depending on the performed refurbishment works and taking into consideration the current condition of the units, an increase in efficiency of 1% to 3% is targeted. At present the units 1G11 and 1G12 show a
much better hydraulic performance. It can therefore be assumed that units 1G7 to 1G10 can be upgraded to at least a similar efficiency level of 94.3% by replacing and modifying the hydraulic ‘sensitive’ parts. MESL’s rehabilitation programme will mainly focus on units 1G7, 1G8, 1G9 and 1G10.

**Jebba Dam**

The Jebba dam comprises of an earth and rock-fill dam wall and several auxiliary dams. The main dam is 670m long and 42m high, and has a capacity of 3.22 BCM.

The main dam is located approximately 100 km south of Kainji dam and is followed by a lock and three auxiliary concrete dams (noted as dams 4, 3 & 2). Between these auxiliary dams there is an emergency concrete spillway and powerhouse with water inlet. The spillway and auxiliary dam 1 is rock fill with earth core similar to that of the main dam. A saddle dam, of the same type as the main dam, closes a secondary valley.

The powerhouse is equipped with six turbines and six turbine-alternator groups. Each of the propeller turbines is rated at 96.4 MW for a net head of 102 MW at maximum output. The total nominal power installed is 578 MW. A schematic layout of the dam is shown in Figure 2.
Jebba HPP comprises of 6 identical generating units having an output capacity of 96.4 MW each, at a rated net head of 27.6 m and a discharge of 385 m³/s. Generating units have a maximum output of 102.9 MW each at a maximum net head of 29.3 m. All turbines are of the fixed blade (propeller) type runners and have a clockwise rotational speed of 93.75 r.p.m; they were originally manufactured by Andritz (former Escher Wyss). The six installed units have a total capacity of 578.4 MW. The aim of the Capacity Recovery Plan (CRP) is to re-establish the rated power output of 578.4 MW of the hydropower scheme of Jebba until the end of November 2018. Of the six turbines (2G1 – 2G6), there are two (2G4 and 2G6) that are not operating. In order to achieve this target, the following components have been assessed:

- LV distribution and replace distribution panels for ventilation system;
- Fire-fighting system;
- Repair of HVAC system; and
- Repair of small power and lighting in powerhouse.

The predecessor concessionaire (Power Holding Company of Nigeria - PHCN) of Jebba HPP has awarded a rehabilitation contract to Hitachi for the rehabilitation of unit 2G4, which will be funded in the form of a grant provided by the Japanese Government. The MESL’s rehabilitation programme will focus primarily on repowering unit 2G6, which went out of operation in 2009, since rehabilitations works on unit 2G4 are already in execution by Hitachi and units 2G5, 2G3, 2G2 and 2G1 are in sufficiently good condition and no major refurbishment works need to be considered until November 2018, as indicated in the 2014 Jebba Capacity Recovery Plan.

**Justification of the Project:**

Nigeria has a population of 180 million and currently suffers from endemic low power supply. Of the current installed capacity of 13,308 MW, only 6,158 MW was operational in 2014, and of this only between 3,000 MW and 4500 MW is actually being generated due to operational and grid constraints. There is therefore significant demand to improve electricity availability by improving current infrastructure and / or installing new generating capacity. Electricity generation capacity and efficiency of both Kainji and Jebba HPPs has declined significantly through several decades of operations. The proposal to upgrade generating capacity of the dams is therefore justified by the immediate need for rehabilitating current infrastructure. The aim of the Capacity Recovery Plan (CRP) is to increase the rated power outputs of Kainji and Jebba HPPs to the minimum design ratings of 750 MW and 578.4MW respectively. With the existence of the two dams, no alternative sites or plant layouts were considered.

Not proceeding with the Project will therefore minimise the opportunity to extend infrastructure serviceability and increase power outputs. As a consequence, it is anticipated that there would be a deterioration of the plants and subsequent breakdowns, leading to severe adverse effects on electricity generation and associated livelihoods and economic development.
4. DESCRIPTION OF THE PROJECT ENVIRONMENT

Physical Environment

Geology: The Kainji and Jebba dams are situated on the Basement Complex rocks of Africa. Several rock types, such as granitic, dioritic and hornblende-biotite gneiss, diorite, mica quartzite and pegmatite and dolerite (the last two as intrusives) are noticeable encountered at Kainji. The massive outcrops of granite gneiss cover nearly 50% of the area, whereas diorite and quartzite each occupy another 10%. The dioritic and hornblende-biotite gneiss constitute the remaining 30% of the area. Both concordant and discordant pegmatite veins, 3-25 cm wide are reportedly present in the gneiss. The other intrusive rock, dolerite, also occurs mainly as veins. These rocks are characterized by the presence of a threefold system of joints - porphyritic granite, mica quartzite and diorite. The quartzite is highly jointed. The tectonic origin of these joints is supported by their structural relationship with the axes of the folds, though minor, in the area.

Climate: Kainji and Jebba dams lie in a transition region, dominated by dry continental trades during the dry season and moist maritime equatorial air during the wet season. The months of April to October are rainy with maritime air blowing from the south. The months of November to March are on the other hand dry with Saharan air from the north. The climate is described as hot equatorial with high maximum temperatures and an average daily maximum of 33.5°C in the warmest month while the mean annual temperature is about 30°C. The annual rainfall in the area of the lake is about 1000 mm. This rain is almost entirely confined to a period beginning about mid-April and extending to mid-October, and much of it is associated with line squalls occurring between late afternoon and early morning.

Hydrology and Water Resources: About half the annual inflow to Kainji and Jebba Lakes originates in runoff from the basin south of Naimey as "white flood", entering the lake beginning in mid-August and lasting until December. This water is highly turbid (Secchi disc transparency about 0.3 m) and grayish. The rise to a highly variable peak is rapid and the flood starts to diminish in late September or early October. The balance of the inflow originates in rains at the headwaters of the Niger in the Guinea highlands. This water, having passed through the flats around Timbuktu, is much clearer and is known as the "black flood". It is considerably delayed and rises in October continuing into May. Although rising soon after the white flood, it does not reach its peak until February and does not cease until the latter part of April. The annual flow may reach about 80 000 million m3 in a year of high flow, of which 47 000 million is obtained from the white flood and the balance, 33 000 million, in the black flood. The latter is relatively constant from year to year while the white flood may be reduced by as much as one third in dry years (FAO, 1973). The main watercourses contributing to the dam catchments are the Niger, Olli, Kaduna and Gurara rivers, and several tributaries that flow into them (Figure 3). Dam reservoirs (Lake Kainji and Lake Jebba) are both located on the Niger River and serve as the main water source for Kainji and Jebba HPPs. Kainji Lake forms the head reservoir for both HPPs.

The recent bathymetry survey (SMEC, 2014) indicated that storage capacities of both reservoirs have declined (11% & 18% for Kainji and Jebba respectively); an indication of some sedimentation of the dams since their constructions.

Biophysical

Vegetation: The floristic composition of the arboreal vegetation in the region is strikingly uniform and is little influenced by difference in physiognomy. The majority of species are adapted to a savanna
environment in that they are resistant or tolerant to fire and regenerate easily from coppice or root-suckers. Fire-tender species, which in some parts of the Southern Guinea Zone grow in the lower strata of mature savanna woodland are absent or rare. However, the major factor contributing to this floristic uniformity appears to be the narrow range of variation in moisture conditions in most of the habitats; many soils tend to be deep, permeable and well drained and provide a good medium for growth.

![Figure 3 Hydrology of the project area](image)

**Biodiversity Resources:** The vegetation of both sectors of Kainji and Jebba dams lie within the Northern Guinea Savanna, which is Savanna woodlands dominated by tree species such as *Aflezia Africana, Isorberlinia tomentosa, Monotewse kerstingii, Burkea Africana, Isoberlinia doka, Crossopteryx ferbrifuga, Anogeissus leicaropus, Khaya senegalensis, Terminala avicinoides, Butryos permum paradoxum, Terminala macroperata, Retarium microcarbum, Diospyros mesapiformis* and *Maytemus senegalsio*. Prominent shrubs include *Piliostigma thonningii, Anona senegalensis, Strychnos inouca* and *Gardenia sp.* The herb layer is dominated by the following grasses: *Andropogon gayus, Andropogon tectorum, Hyparrhenia sp.* and woody forbs such as *Cochlospermum tinctorum* and *C. Planchonii with planchonii* (Bako et al., 2015). Notable among the terrestrial fringing plant species are *Danielliaoliveri, Acacia spp., Anogeissusleicaropus, Burkeaafricana, Afzeliafricana, Khayasenegalensis, Parkiabiglobosa, Detariummacrocarpum, Pterocarpus erinaceous, Andropogonspp.* and *Hyparrheniaspp* (SMEC, 2015, Livelihood Support Report).
The impoundment of the reservoirs has led to the loss of aquatic biodiversity, wildlife habitat and species diversity. Dam impoundments have also impacted on the movement of some species leading to changes in upstream and downstream species composition. Aquatic weed is a menace on Kainji and Jebba reservoirs, and various methods have been adopted in the past to control its spread. A major effort to conserve the biodiversity resources of the project area is the establishment of the Kainji Lake National Park in 1979.

**Fisheries:** The fisheries in Kainji and Jebba reservoirs comprise of a large number of species and there is significant variation in fish size, composition and spatial distribution. There are 52 different species of fish from 21 families. Of these, 11 threatened species are present in Kainji reservoir and six threatened species in Jebba reservoir. These include *Arius* sp., *Hepsetus* sp. and *Citharinus* sp. Current threats to aquatic diversity include overfishing proliferation of aquatic macrophytes, mainly by *Eichhorniacrassipes*, *Pistiastratiotes*, *Nymphaea lotus* and *Salvinianymphellula*. There is an annual surge of water hyacinth from the upper reaches of Lake Kainji, which has been continuously cleared since 1994. An intensive community management programme has reduced the aquatic weed problem in recent years.

**Wildlife:** Terrestrial wildlife species found in the area include hippopotamus, buffalo, roan antelope, kob, bushbuck, red-flanked duiker, warthog, cane rat, baboon, aardvark, marsh mongoose, African civet, genet, manatee and lion. However, species like Roan antelope, Hartebeest, Red flanked duiker, Bush buck and Warthog are present at the Park. The three major primate species recorded in the Sector are Mona monkey, Green monkey and Red patas monkey. Others include crocodile, python, monitor lizards, tortoise, turtle, cobra, water snakes, fish eagle, heron, darters, birds of prey, cattle egret, ground hornbill, secretary bird and waterfowl, frogs and toads. Domestic animals including cattle and goats are common. The lake is also an important ground for Palaearctic migrant water birds.

**Biodiversity loss:** The Kainji Lake National Park (KLNP) authorities have not reported any serious threats to the existing flora and fauna in the Park due to dam operations. Catchment management includes community participation in preserving natural areas and policing illegal tree felling. The main threat relates to people living around the reservoirs, where fish are abundant. Overall, there is no presence of endangered species that could be affected or subjected to extinction as a result of the project activities. In this regard, it could be concluded that there are no species of global significance in the project area; therefore the project activity will not contradict the UNCBD convention on biodiversity.

**Socio-Economic Environment**

**Land use:** The floodplain around Kainji and Jebba reservoirs has good fertility and is extensively farmed, with soils being regularly replenished by flood waters. Flatter slopes also favour ease of access and construction, and efficient supply of water and other services. Thus, despite the potential hazards of floods, people have consistently settled on these plains. One hundred and forty one (141) settlements are within the Kainji dam plains, comprising mostly of the initial 40,000 to 50,000 people that were originally living in 239 hamlets, villages and towns. Fourteen (14) settlements, comprising some 6,099 people in original 42 villages are located in the Jebba dam flood plains. In general, farmlands downstream of the dams are vulnerable to flood damage. Thus the sustainable development of the project area requires that the people settled along the dams’ flood plains are properly carried along and adequately consulted.
Communities: Some 437,212 people live within the dam catchments (Niger, Kwara and Kebbi States) comprising 438 settlements and 44,432 households. A recent detailed assessment of flooding within the dam catchments indicates that approximately 103 communities with a population of 131,918 are prone to flooding. These are mostly post inundation settlements of fishermen and farmers that are close to the reservoirs or Niger River bank. The major religions of residents in the project area are Islam and Christianity. A minority of the population are adherents of African Traditional Religion. Most of the local residents around both dam site areas are Muslim.

The most important groups in the dams’ areas relate to informal work exchange groups (Table 4.5). These groups are very significant for both farming and fishing activities, as well as for processing activities of the women. Informal savings and credit groups, known as adashe or esusu, are more common in the southern areas of Jebba than the northern areas around Kainji. Similarly, cooperatives are more common in the southern areas.

Economic activities and socio-economic status and vulnerability: The socio economic profile of the catchment areas of the dams shows a per annum income of Naira 28,675. The major activities engaged in by the communities provide varied contributions to their overall income. While a majority of the people is engaged in crop farming, fishing provides the highest contribution to overall income; followed by farming, fish farming, livestock and trading.

Health: Access to modern health care is difficult for residents in the dam areas. In most of the rural communities there are no facilities and residents typically rely on traditional health care unless there is a very serious medical problem. However, 90% of the settlements had some form of health centre or hospital within 5-10km that takes care of its healthcare needs (SIA Report). Major health facilities in urban centres and the wider vicinity of the dam areas are: Borgu General Hospital, Jebba Specialist Hospital, and Mainstream Hospitals at Kainji and Jebba. There are also several private health facilities in the urban centres of Borgu and Jebba.

Education: The educational status of residents in the dam areas is generally low. Over half (54.9%) of the total population has no formal education and only about 20 % have secondary education or higher. There are few educational facilities in the dam site areas as shown by the findings on educational facilities in the sampled communities. There are several primary schools, but the quality of the structures may be very poor. Few secondary schools are found in the larger communities visited. There are no tertiary institutions in the area.

Infrastructural Development, Access and Traffic: In general, the level of infrastructural development in the project area is very low. The most basic facilities and services to provide potable water, elementary formal education, health services and access road are lacking in most communities, despite some earlier attempts by the PHCN to assist several local communities by providing some facilities, specifically water, schools and health centres. A very notable, but disturbing feature of the infrastructure situation in the project area is that most of the initial facilities provided by PHCN have not been properly maintained and in some cases are no longer functioning.

The common forms of transport are commercial buses, canoe, motorcycle and bicycle. Trucks and lorries are common in some locations, and ferries are common on the reservoirs and rivers. There is however poor road linkage in the rural communities, which presents a challenge to accessibility. Most villagers consulted reported that roads have improved since the dams were constructed, but there remain significant difficulties with transportation during the wet season.
Cultural Heritage and Sites of Social Significance: Under the IFC (2006) Performance Standards for establishing development projects, protecting social heritage is advised. While the loss of cultural heritage sites was significant during construction of the two dams, there are no significant sites within the rehabilitation project footprint. Sites of social significance may include traditional or modern places of worship, including sacred forests or water bodies, cemeteries or historical sites of local importance. In the sampled communities of study areas, there were no reported traditional religious sites and so there is very little likelihood of disturbing any such sites.

5. PROJECT ALTERNATIVES

The No Action Alternative: This alternative is the option of not undertaking the rehabilitation of both the Kainji and Jebba dams for electricity production or generation for Nigeria. When the no action alternative is considered, it can be said that this alternative is generally not preferred for energy production aimed projects that will generate public benefits to the country. When the no-action alternative is chosen the following consequences may take place:

- Need to decommission the plants to avoid potential catastrophic consequences of the collapse of the dams from underutilization of their water resources, including adverse ecological impacts, such as existing river hydrology in the downstream section, aquatic life and socio-economic activities of the people living along the river in both locations.
- Need of establishment of alternative plants for the much desired energy in the country, such as thermal or nuclear power plants, or the utilization of gasoline, diesel and fuel-oil fueled individual generator sets which are less economical, have other adverse impacts on the environment, and are not as sustainable as using a renewable source for energy production.
- Limitation of social and economic development in the country.
- Loss of employment opportunities for people operating and managing the dams.

Therefore, the No-Action alternative is not a reasonable alternative and it is necessary to implement the rehabilitation of the plants to improve energy availability and access in Nigeria for its much desired development to meet the socio-economic needs of its 170 million people.

Kainji HPP Rehabilitation Alternatives: Based on different assumptions regarding possible turbine efficiency increases and turbine discharge increases the following four refurbishment scenarios were assessed:

1. Emergency Recovery Scenario: This considers the refurbishment works which are required to put back into operation as fast as possible units 1G7 to 1G10 without considering the general overhaul of the units. The Emergency Recovery Scenario can be combined with the Basic Scenario, Scenario A and Scenario B that are described below.

2. Basic Scenario: Considers a general major overhaul of the turbines and the generators as well as of the associated equipment in order to have the installations fit for their purpose for the next 30 to 40 years. An improvement compared to today’s condition of 1% of the turbine prototype efficiency is assumed in this scenario.

3. Scenario A: This considers the replacement of all turbine parts, which are particularly sensitive for the turbine efficiency improvement. Its main target is to have a maximum of power output by means of turbine efficiency as high as possible. An improvement compared to today’s
condition of 2.5% of the turbine prototype efficiency by performing extended rehabilitation works is assumed in this scenario.

4. **Scenario B**: Combines an increase (in its limits) of the turbine discharge with an increase of turbine efficiency. It is the most challenging solution, which main target is to have the maximum possible turbine power output. Assuming an initial efficiency level of 93.3% at rated condition, today’s efficiency level is estimated to be around 91.3%. Estimating an improvement of approx. 3%, the efficiency level of the turbines under Scenario B should reach approx. 94.3%, which represents an improvement of approx. 1% compared to the as built condition.

Table 1 shows clearly that the **Emergency Recovery Scenario** as well as the **Basic Scenario** allows completion within the deadline for restoring the full capacity (assumed to be on 30. November 2018). In contrast, **Scenario A** misses this target by approximately 10 months and **Scenario B** by more than 2 years.

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<th>Completing Date</th>
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<td>Emergency recovery combined with basic</td>
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</tbody>
</table>

The attractiveness of **Scenario B** depends mainly on the possibility to increase the turbine discharge. Assuming an increase of 5%, which is rather on the conservative side, the results for Scenario B is not very attractive. However, if the unit discharge is increased by about 10%, it will result in an increase of the capacity by approx. 7% compared to the initial installed capacity. At that point, Scenario B becomes more interesting. Since the discharge limits of the penstock and embedded parts of the turbine (spiral case, stay ring and draft tube) are crucial aspects for the power output increase, a careful and detailed verification of these components need to be performed by the turbine supplier. If the completion date for the capacity recovery must be respected without any delay, only the Basic Scenario can be considered. As the Emergency Recovery Measures do not influence the final completion date, these measures are highly recommended for additional energy production. Thus, if the completion date for the capacity recovery can be extended, Scenario B might be a valid option. However, the aspects of the hydraulic limits of waterway (penstock, spiral case, stay ring and draft tube) and operation mode and pricing during peak hours of the concerned systems remain uncertain for Scenario B.

In light of the above the combined **Emergency Recovery Scenario** and the **Basic Scenario** was adopted in this project for the rehabilitation of the Kainji Hydropower Plant.

**Jebba HPP Rehabilitation Alternatives**: The rehabilitation programme for Jebba HPP will primarily focus on repowering unit 2G6 (*Table 6*), since rehabilitation works on unit 2G4 are already in execution by Hitachi on the one hand and the units 2G5, 2G3, 2G2 and 2G1 are in sufficiently good condition on the other hand, that no major refurbishment works need to be considered until November 2018 (except for
replacement of unit protection). The completion dates, capacity increases and investment costs of the project are given in Table 2.

**Table 2** Completing date, capacity increase ad investment for different rehabilitation scenarios for the Jebba Plant

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Completing Date</th>
<th>Capacity Increase (%)</th>
<th>Total Cost (USDm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2G6</td>
<td>20/02/2017</td>
<td>None, as built</td>
<td>27.06</td>
</tr>
</tbody>
</table>

As this is the only scenario that was worthy of being studied, it was adopted in this project for the rehabilitation of the Jebba Hydropower.

**6. POTENTIAL IMPACTS**

**6.1 Positive Impacts**

**Impacts during turbine replacement/refurbishment – construction phase**

*Employment and income generation*: The reservoirs’ infrastructure constructions are labour intensive activities and for that reason, the labour needed in the project area will create much needed employment opportunity to the rural population in the project area. The developer will commit to a policy that gives priority to the locals in the neighborhood at the time of employing casual or skilled labor. It is also anticipated that indirect employment opportunities will be created within local communities through the provision of services to the construction teams, such as the sale of food and beverages. Because of the technicalities involved, the number of additional workers is not expected to be large.

*Influx of people*: In the course of refurbishing the hydropower plants, more people are expected to move into the project are. The added value of people with diverse backgrounds living in the project area during the construction period will add value to the socio-economic condition of the areas where the dams are located.

**Impacts during the Operation Phase**

**Physical Impacts**

*Flood control*: The dams will control floods downstream by storing water, channeling and evacuating excess water, especially during heavy rains. Flood control effect of the project will keep much of the agricultural areas downstream of the dam from being flooded and free more land for farming as well as prevent destruction of food crops for those farmers exploiting the command area in the wet season. Flood control will thus help achieve food security.

*Water resources management*: Improve water resources management in such a way that it benefits power generation, agricultural production of the riparian communities; and reduce damages caused by flooding and sedimentation. The proposed rehabilitation works will improve efficiencies of existing turbines, which may change current flow regimes.
**Climate Change Abatement**: Electricity generated by the Kainji and Jebba HPPs will reduce the necessity to provide power from non-renewable resources such as oil and coal. Consequently overall carbon emissions will be reduced, thereby reducing potential impacts on climate change. The Kainji Project was registered as a Clean Development Mechanism (CDM) project on 28 December 2012 under the United Nations Framework Convention on Climate Change (UNFCCC). The CDM registration is a key step to generate Carbon Emission Reduction credits which the plant will benefit from if rehabilitation is undertaken and the plant is able to restore installed capacity. The Crediting Period is expected to run from 1 January 2013 to 31 December 2022. Within the ten year period estimated greenhouse gas (GHG) emission reduction for Kainji is estimated with rehabilitation concluded to be 8,734,742 of carbon dioxide (CO$_2$e).

**Revegetation**: Improved reservoir and canals protection activities resulting from renewed operations of the dams will improve the vegetation in the surroundings of those irrigation infrastructures and other erosion susceptible areas. This activity will increase the forest cover in the silt trap and erosion prone areas and promote the sustainability of the surrounding habitats and ecosystems.

**Socio-economic Impacts**

*Increased Power Generation and Provision of Reliable Electricity to Industries*: The rehabilitation of the two power plants will contribute to generating a more stable power supply to the national grid system. Increased and reliable power is of great importance to economic growth and development in Nigeria.

*Impacts to Economy and Society*: The project will create increased opportunities for individuals and organizations in Nigeria to utilize electricity. This will enhance livelihood potential of both rural and urban dwellers through employment and business development opportunities, and skills development.

*Improved Infrastructure*: Improved infrastructure such as roads and electricity services are expected with the rehabilitation of the dams. With improved efficiency and capacity of the Kainji and Jebba Hydropower plants in the project area, the presence and the operation of the project will potentially bring about the improvement of existing infrastructure and introduction of new infrastructure. For example, the rehabilitation of exiting health facility and access roads for the project’s, as well as the provision of new one commensurate with increasing population in the basins since the initial construction of the dams will bring additional benefit to the immediate and the surrounding communities.

*Employment generation*: The implementation of the project will result in the creation of new employment opportunities for surrounding local communities in Kainji and Jebba environments and Nigeria in general. This will include opportunities for employment on reservoir sites as well as various aspects of infrastructure development and maintenance. Substantial economic diversified effects will result during the operation of the project.

*Increased business activities for poverty reduction*: Influx of people to the area is expected to increase business activities, improve income generation and reduce the general poverty of the people in the basins.

*Increased Potential for Corporate and Community Understanding*: The conduct of the ESIA, which was absent during the initial construction of the dams, has encouraged the adoption of participatory
approach and sustained dialogue in the operationalisation of the project. Through improved understanding of corporate social responsibility by MESL, this project offers an opportunity for improved relations between the management, project workers and the host communities.

**Impacts during the Decommissioning Phase**

There will be no clear positive impact of dismantling and decommissioning the dams

**6.2 Negative Impacts**

**Impacts during turbine replacement/refurbishment – construction phase**

*Increased potential for road traffic volume and risk of accidents/injuries:* It is anticipated that road traffic will increase for a short period during mobilization equipment to the hydropower plants. Traffic is also expected to increase because more people and vehicles will be expected at the project area. Increases in the volume of traffic have the potential to increase the risk of accidents and noise levels in the project area.

*Influx of People:* Population increase that is expected from influx of people to the project area could cause some temporary alteration of the age-sex distribution as most of the workers are likely to be men, increase pressure on existing infrastructure, possible increase in communicable diseases (including STIs), increase in social vices and stress on existing security.

**Impacts during the Operation phase**

**Physical Impacts**

*Dam failure-induced flooding:* Although the probability of failure of a dam is generally low and perhaps rare, flooding due to dam failure of Kainji and Jebba dams could occur. This will produce a disaster to downstream riparian communities. If the dams fail, property damage is certain, but loss of life can vary dramatically with the extent of the inundation area, the size of the population at risk, and the amount of warning time available. In general, the consequences of a catastrophic dam failure are enormous. It affects not only lives and property, but also the community, its economic well-being and the natural environment. The communities likely to be affected during floods are identified, and a database developed for people at risk (PAR) during floods of different magnitudes and during dam break. Modelling showed the following: during a 100-year flood an area of 807 km2 would be inundated, potentially affecting 45,741 people, and for dam break an area of 1272 km2 would be inundated, potentially affecting 131,918 people. The arrival time of the dam break flood wave has been estimated, and a procedure discussed how to use the map and the graph of time of arrival against reach/station location. A database of higher grounds for evacuation and existing roads and trails has also been prepared to facilitate evacuation in a flood emergency. A comprehensive identification of villages affected by flood and verifying the flood map were also developed (SMEC, 2015, Hydrologic Modelling and Flood Mapping).

*Hydrology and sedimentation:* The proposed rehabilitation works may improve efficiencies of existing turbines, which may change current flow regimes. The run-off characteristics would alter over the long
term, resulting in possible alteration to the hydrological characteristics of river Niger and increasing sedimentation in the basins for the project.

**Flooding and Environmental Degradation:** The inhabitants in the vicinity of the dams can experience problems relating to flooding, erosion, pollution and loss of soil fertility. The consequence of flooding in the area are destruction of farm lands and produce, loss of valuable property, erosion, damage to roads and community infrastructure which leads to reduction in income and increased poverty in the riparian communities, as demonstrated in 1998, 2010 and 2012 that exhibited substantial flooding along the Niger River, which affected the project area.

**Soil erosion and catchment degradation:** Continuous and uncontrolled deforestation, uncontrolled grazing and fires by increasing population in the basins of the hydropower plants (Kainji and Jebba) could increase the chances of erosion.

**Water Quality:** While water for driving the turbines creates very little potential for contamination a number of processes occur within the plant and the associated offices that may introduce both chemical and biological agents into the waters, and thereby contribute to reduce the quality of water in the concerned basins. These activities include: (i) transport, use and storage of chemical agents used for electricity generation; (ii) release of transformer oils; (iii) use of lubricants; (iv) electrolyte fluids for battery maintenance; (v) degreasers; (vi) substances present in fire-fighting equipment, in the event of release; (vii) fumigants and pesticides; (viii) detergents and other cleaning agents; and (ix) substances used in the water treatment facility, including aluminium sulphate; and sodium hypochlorite

**Terrestrial and aquatic flora and fauna:** Water hyacinth (Eichhorniacrassipes (Martius) in the reservoirs threatens both the turbines for power generation and the livelihoods of the riparian communities by impeding fishing and navigation. This aquatic weed first appeared in 1989 and by 1995 it covered approximately 23% of the reservoir area. Potential impacts include; a hindrance to boat traffic, provides habitat to dangerous snakes, blocks beaches, dislodges set nets, kills livestock, kills the Niger grass on which livestock feeds and reduces fish breeding grounds. The management is aware that activities of cattle grazing near the dam is responsible for the spread of weeds and is in constant dialogue with communities in order to find a lasting solution to this problem. It is not expected that the rehabilitation project will increase the prevalence of water hyacinth or effect its current management.

**Occupational Health and Safety Impacts and Epidemiology:** Workers will be exposed to occupational health and safety hazards during the rehabilitation work and in the operation and management of the power plants. Potential hazards relate to operational accidents, flood and dam breaks, and exposure to live wires, chemicals, tools and machinery. The adverse impact of dams on human health is increasingly recognized because of its disruptions and environmental changes with negative health impacts. The expected range of illnesses and disease for host riverine communities include HIV/AIDS, water borne diseases, malaria, onchocerciasis and schistosomiasis.

**Waste:** Waste will increase from (i) use of office materials (paper, furniture etc), (ii) use and maintenance of machinery within hydroelectric plants, including packaging materials, machine parts and tools, and (iii) materials used in medical treatment such as syringes, wound dressings and medical drugs etc. Exposure to such waste is a potential risk to individuals, communities and the environment if not properly managed.
**Socio-economic impacts**

*Increased potential for road traffic volume and risk of accidents/injuries:* It is anticipated that road traffic will increase for a short period during mobilization equipment to the hydropower plants. Traffic is also expected to increase because more people and vehicles will be expected at the project area. Increases in the volume of traffic have the potential to increase the risk of accidents and noise levels in the project area.

*Influx of People:* Population increase that is expected from influx of people to the project area could cause some temporary alteration of the age-sex distribution as most of the workers are likely to be men, increase pressure on existing infrastructure, possible increase in communicable diseases (including STIs), increase in social vices and stress on existing security.

*Changes and Challenges in Income Generation around Dam Sites:* According to a recent survey there is a general perception that there had been a decline in livelihood activities over the past 20 years as a result of dam operations, due to incessant flooding and reduction in land for farming.

**Impacts during the Decommissioning Phase**

**Physical Impacts**

*Flooding and Environmental Degradation:* The inhabitants in the vicinity of the dams would experience increased problems relating to flooding, erosion, pollution and loss of soil fertility. The major problem, however, is flooding, as decommissioning will mean inability to regulate the two distinct flood regimes (while and black floods) of the River Niger on which the plants are located. This will lead to massive and disastrous flooding of communities, erosion and general environmental degradation of the whole basin of river Niger from Lake Kainji to the Niger Delta. This is definitely unacceptable.

**Socio-Economic Impacts**

*Unemployment and increased poverty:* Decommissioning the plants will lead to total loss of job and business opportunities in the basins, resulting in loss of income, loss of jobs and business opportunities and increasing poverty in the project area.

*Community unrest:* Massive flooding that will result in further displacement of communities in the project area, which may result unrest among the people in the project area.

7. **MITIGATION MEASURES AND COMPLIMENTARY INITIATIVES**

The mitigation measures proposed for the predicted medium and high-ranking impacts arising from this proposed power plant project took into consideration the following:

- Relevant environmental laws in Nigeria;
- Best Available Technology for Sustainable Development;
- Feasibility of application of the measures in Nigeria; and
- Concerns of stakeholders during consultations

Proposed impact mitigation measures took cognizance of the need to involve or reflect all or some of the following:
i. Avoiding the impacts altogether by not taking a certain action or parts of an action.

ii. Minimizing the impacts by limiting the degree or magnitude of the action and its implementation

iii. Rectifying the impact by repairing, rehabilitating or restoring the affected environment

iv. Compensating for the impact by replacing or providing substitute

The proposed rehabilitation works focus primarily on aspects of the generation capacity of the HPPs and will take place within the existing facilities. Overall significant environmental hazards of the magnitude witnessed during the construction stages in the 1960s and 1980s will not occur.

There are currently systems in place to manage Kainji and Jebba HPP activities and a range of new initiatives have been recently undertaken to further develop management systems to meet international standards.

In putting in place the mitigation measures and initiatives, MESL recognizes that it is not solely responsible for the management of flood and water resources in the project area. There are several agencies involved and inter-agency cooperation on flood control and water resource management is important. The major stakeholder institutions in flood and water resources management include (i) Dam operator – Mainstream Energy Solutions Ltd, PMU; (ii) Federal Ministry of Water Resources (FMWR); (iii) Niger State Ministry of Water Resources; (iv) National Emergency Management Agency (NEMA); (v) Nigerian Hydrological Services Agency (NIHSA); (vi) Nigerian Meteorological Agency (NIMET); (vii) State Emergency Management Agency (SEMA); (viii) Kainji Lake National Park (KLN); and (ix) Ecological Fund and other government ministries, departments and supporting agencies. The Jebba and Kainji Dams Safety Management Plans (SMEC 2013) enumerate the responsibilities of the dam owner, dam operator and the regulatory authority of the government. Key environmental and social measures that are currently in place are summarized below:

Mitigation measures during rehabilitation

*Increase in potential for road traffic volume and risk of accidents/injury:* Power plant Management shall (i) ensure effective journey management plan; (ii) ensure pre-mobilization inspection of all vehicles before deployments; (iii) place visible warning signs on roads and vehicles in the project area; (iv) enforce compulsory medical fitness test for all personnel; (v) provide First Aid training for the workforce; (vi) put in place emergency response procedures and enforce safety awareness training for workforce and representatives of host communities; (viii) embark on accident prevention campaign and other related initiatives.

*Movement of heavy equipment to work which may pose danger to public:* MESJ shall: (i) install speed breakers at sections of the road traversing communities; (ii) ensure proper scheduling of vehicle movement so as not to interfere so much with local fishing activities; (iii) sensitise local drivers on company’s safety plan; (iv) schedule large and slow moving vehicles during off-peak periods; and (v) raise community awareness of unusual activity; and (vi) conduct compulsory defensive driving training for all drivers.

*Pressure on existing infrastructures:* Existing infrastructure shall be maintained with a view to improving functionality.
**Possibility of electrical accidents from faulty electrical connections or personnel carelessness:** Project Management shall: (i) conduct daily HSE briefings prior to work; (ii) ensure electrical connections are inspected and tested before use; (iii) ensure adherence to safe work practices; (iv) provide appropriate training to personnel and contractors.

**Increase in waste generated:** Implement in totality MESL’s waste management plan for sustainable waste management from source to final disposition.

**Water quality:** Project management shall undertake monthly sampling and analysis to determine quality of water and implement appropriate recommended treatment in the waste management plan to reduce pollution, as detailed in its Environmental Management System/Plan.

**Mitigation measures during operations**

**Dam failure-induced flooding:** A Dam Break and Flood Early Warning System study (SMEC, 2014) was carried out, communities affected were identified and an early warning system was put in place to warn the communities through File Transmission Protocol for the public, Cell-Phone Dissemination, Radio Broadcasting and Billboards. The Early Warning System will be monitored during project implementation. The affected communities are mostly fisherman who can be evacuated with relative ease. Some communities have been allocated new land by the Federal Government of Nigeria, prior to the privatization of the two power plants. MESL shall (i) profile risks facing the dams and their appurtenant structures such as spillways, navigation locks etc that can arise from multiple sources, including (a) naturally occurring risks (such as those associated with floods and earthquakes); (b) structural deficiencies; (c) accidents; (d) equipment malfunctions; (e) aging infrastructure; and (f) deliberate aggressor actions (such as those associated with terrorism and sabotage); (ii) implement dam management plans already developed by MESL including (a) Dam Safety Management Plan; (b) Dam Safety Surveillance Plan incorporating the Instrumentation Plan (IP) and Dam Safety Inspection Plan; (c) Dam Safety Emergency Plan (DSEP); and (d) Dam Operations and Maintenance (O&M) Plan. The DSEP, for instance, highlights the implementation plan for flood warning and people at risk (PAR) from Kainji and Jebba HPPs. The DSEP specifies the roles and responsible of parties when dam failure is considered imminent, or when expected operational flow releases threaten downstream life, property, or economic operations that depend on riparian flows. The plan includes the following items: (i) clear statements on the responsibility for operational decision making and related emergency communications; (b) preparation of flood maps that outline inundation levels for various emergency conditions; (c) flood warning system characteristics; and (d) procedures for evacuating threatened areas and mobilizing emergency forces and equipment.

**Hydrology and sedimentation:** Project Management shall (i) carry out continuous bathymetric surveys in the headwaters of Kainji Reservoir and main tributaries to Jebba reservoir; (ii) optimise the water use of the dams; and (iii) implement sediment load sampling in the Niger River at Jidere Bode Gauging station and the main tributaries to Kainji reservoir below this station and into the Jebba reservoir.

**Floods:** Project Management shall: (i) update on a regular basis flood maps to identify vulnerable areas; and (ii) implement MESL’s Emergency Preparedness Plan and Flood Warning System for both Kainji and Jebba reservoirs, and downstream to Pategi/Baro at the confluence of the Kaduna and Niger Rivers.
Soil Erosion: MESL to (i) conduct continuous monitoring using satellite imagery to identify areas and rectify using reforestation; (ii) develop and implement a catchment management programme; and (iii) involve local governments and communities in the basins in catchment management.

Water Quality: MESL shall undertake monthly sampling and analysis to determine water quality and appropriate action to minimise impact.

Climate Change Impacts: Management to adapt national climate change approaches for climate smart approach to water resources management in the basin.

Health: MESL shall: (i) upgrade existing 60 bed hospital; (ii) improve access to clean water; (iii) introduce household level intervention – solar disinfection, chlorination, boiling of water; (iv) raise public awareness on critical health issues in the project area; (v) conduct epidemiological monitoring; and (vi) make workers to be aware of safe practices for drinking water and water related diseases, as well as safe practices for communicable diseases in worker safety risk assessments.

Possibility of electrical accidents from faulty electrical connections or personnel carelessness: Project Management shall: (i) conduct daily HSE briefings prior to work; (ii) ensure electrical connections are inspected and tested before use; (iii) ensure adherence to safe work practices; (iv) provide appropriate training to personnel and contractors.

Waste: Implement MESL’s waste management plan for sustainable waste management from source to final disposition.

Influx of people or increase in population resulting in various vices: MESL shall: (i) provide skill acquisition training to enhance capacity of the people to cope with increasing business opportunities for job creation; and (ii) implement MESL’s Livelihood Support Plan to reduce potential impacts of increasing population pressure.

Mitigation measures during decommissioning

Massive flooding and land submergence: Project Management shall: (i) use appropriate technology and methods for decommissioning to control the gradual release of the waters of the lakes; (ii) undertake additional impact assessment during development of substantive decommissioning and abandonment plan to indicate and implement appropriate mitigation initiatives.

Erosion and ecological degradation. Project Management shall: (i) use appropriate technology and methods for decommissioning to control the gradual release of the waters of the lakes; (ii) undertake additional impact assessment during development of substantive decommissioning and abandonment plan to indicate and implement appropriate mitigation initiatives.

Displacement of communities: Project Management with government support evacuate communities to safe grounds.

Loss of employment: (i) MESL shall provide severance package in line with conditions of service and Nigerian labour laws; (ii) The Power plant Management shall investigate the possibility of some staff retention by new operator(s) in handover agreement; (iii) Power Plant Management shall encourage contractors to provide counseling for affected staff; (iv) Power plant Management shall ensure that the
Contractors adopt a transparent approach towards staff on all disengagements; and (v) Power plant Management shall ensure that the contract for employment of staff shall include information on the date of disengagement.

8. CUMULATIVE IMPACTS AND ENVIRONMENTAL HAZARD MANAGEMENT

This rehabilitation project will take place within an exiting infrastructure and targets principally the restoration or replacement of turbines. With adequate implementation of identified mitigation measures enumerated in Section 7, the cumulative impacts that would result from a combination of the proposed rehabilitation of the KHPP and JHPP and other development initiatives in their areas of influence would be very minimal. They could include (i) impacts on Surface Water Hydrology and Aquatic Environment due to possibility of the construction of 2 dams (one each in Mali and Niger) on River Niger upstream of Kainji Dam; (ii) employment and business opportunities; (iii) increased risk of road and electrical accidents; and (iv) impacts related to construction and operation-generated waste.

*Impacts on Surface Water Hydrology and Aquatic Environment*: Change in flow regime due to increase in generation capacity assisted by Pöyry could have residual effect on the hydrology of the two basins, as well as impact on the aquatic environment, particularly downstream of each plant. A greater residual impact on the surface hydrology of the River Niger around the two HPPs is the likely to be due to the implementation of the plan to construct two large dams upstream of Kainji dam in Niger and Mali. This will require detailed studies to determine possible impact of climate change to available water resources on River Niger in Nigeria and operations of the Kainji and Jebba dams. There has not been any significant negative impact of the dams on the aquatic environment down and potential, but limited alteration of existing flow regime after rehabilitation of the two dams is not likely to add significantly to the overall cumulative impact affecting the aquatic system downstream of the dams.

*Influx of Population and Employment*: The rehabilitation of the dams would only attract technical professionals who may not be available among resident communities. This may generate some resistance among locals who may feel deprived of not benefiting much from the employment opportunities provided by the project. This will require the effective implementation of the MESL’s Livelihood Support Programme and consistent delivery of its corporate social responsibility initiatives to mitigate any residual effect by the project in the area of employment and business opportunities.

*Increase in potential for road traffic volume and risk of accidents/injury*: The rehabilitation project will increase light and heavy vehicles using the local roads throughout the duration of works. The combined volumes of road traffic will place both human and livestock in danger of being injured or killed throughout the life of these projects. Effective implementation of identified mitigation measure, including awareness raising and sensitization of community members will minimize the residual impacts in the area.

9. PUBLIC CONSULTATION AND DISCLOSURE

In preparing this ESIA report over the years the consultation process is implanted at three (3) levels, and built upon what had been established since the construction of the dams. The first level of consultation identifies the social and economic issues in the project area and ensures visible management commitment to addressing them. This level starts with the project conception. The second level streamlines the issues and makes plans for specific actions. This level recognizes various phases of
engagements among project proponent, host community, village council, women/men’s groups, and youth organization. The third level ensures regular communication with stakeholders throughout the project’s life; the second and third levels of consultation commence at project inception and continue through the life span of the project. In all the public consultation and disclosure activities for the project were made to conform to (i) Nigerian Regulations; (ii) Requirements from the Bank’s and IFC Performance Standards; and (iii) MESL’s Policies.

Stakeholder forums were conducted at Kainji and Jebba at different times from 2009 to 2016 for the preparation of various. Community engagement with the riparian communities was done through field work that involved visiting the communities from 8 March to 15 March, 2012. The Environmental and Social Impact Assessment teams interacted with the communities likely to be affected by the rehabilitation both up-stream and down-stream of each of the dams, visiting and collecting relevant socio-economic on the identified communities and sensitizing the communities and their leaders about the forthcoming proposed rehabilitation work. The most recent community consultation took place on 9 February 20016 in Munai community. The forums were attended by World Bank representatives, Niger Basin Authority (NBA) staff, representatives from FMAWR, FME, project staff of PHCN (succeeded by Mainstream), KHEPLC, JHEPLC, Borgu Emirate Council representative, Borgu Local Government, Federation of Borgu Youth, representatives from Nassarawa, Anfani, Awuru, Fakun and New Bussa villages and the press. In addition to stakeholder forums, various engagements and visitations were also made to the dam communities.

The objectives of the public consultations were as follows:

i. Address project issues and concerns pertaining to environmental, safety and social matters promptly in order to manage conflict.

ii. Build consensus on potential impacts identified and to offer mitigatory measures before, during and after the project.

iii. Avoid any misunderstandings about the development of the project.

iv. Ensure that any apprehensions and concerns about the project, nature, scale and impact of the operation have been addressed.

In general stakeholder forums were used effectively to introduce the rehabilitation project to stakeholders and to create a forum to discuss the social and environmental issues of all the close communities. These issues were discussed and common consensus was achieved by the various stakeholders. The community stakeholders expressed the desire for greater corporate social responsibility actions in the areas managed by KHEPLC and JHEPLC.

Collectively the various reports present a stakeholder engagement plan, which identifies relevant stakeholders at the community and national levels. During Project investigations public consultations were extensively carried out with relevant stakeholders at the Federal, State, local and community levels, and vulnerable groups such as women, youths and the elderly.

The concerned communities agreed that the proposed rehabilitation of the HPPs will be of immense benefit to them, once a number of long-lingering concerns are properly addressed. They include: (i) absence of necessary social infrastructure/amenities like pipe borne water, access road etc; (ii) availability of employment opportunities for the indigenes in the plants due to limited skills and technical knowledge; (iii) women access to soft loans and grants to improve their economic empowerment; (iv) encroachment of government agencies on their lands; (v) support to diversify means
of livelihoods beyond fish farming; (v) establishment of modern hospitals and other medical facilities; (vi) provision of standard and well equipped schools etc.

MESL intends to continue to consult with the regulatory agencies, the host community, all stakeholders and other relevant parties concerned with or are likely to be affected by the project at all stages of project development. At the approval of the ESIA for the rehabilitation project, a grievance mechanism to enhance communication among the stakeholders will be developed. This will be achieved by developing a flow of communication as follows:

- An unhindered flow of communication will be developed between KHEPLC, JHEPLC and relevant stakeholders. This will include regular interactive forums, sensitisation programmes, etc., which will be well publicised in order to attain maximum participation. The interactive forums will be monthly and more frequent if necessary, and will focus on community issues, concerns and any complaints raised.
- Installation of an effective early flood warning communication system and the facilitation of necessary training programmes for relevant officers.
- The ESU will operate in close liaison with the communities and their representatives. ESU personnel will be equipped to monitor community concerns and be proficient in conveying the same to KHEPLC and JHEPLC top management for appropriate decision making.
- Mainstream to develop a strategy to project the advantages of the HPPs e.g. irrigation, tourism, etc., and communicate same to the riparian communities and other stakeholders.

The Hydro-electric Power Producing Areas Development Commission (HYPPADEC) will play a facilitative role in grievance reporting, when the Bill establishing it is signed into law.

10. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

The ESMP for the rehabilitation of Kainji and Jebba HPPs has been developed as a separate report (Volume III of the ESIA). The ESMP consists of a series of plans and components outlining management measures to address different impacts throughout the life of the Project. Each individual Management Plan outlines proposed mitigation measures in accordance with proposed performance criteria for specified acceptable levels of environmental and social performance. In line with the Bank’s guideline, the key elements of each Management Plan include: (i) Project Activity; (ii) Anticipated Environmental and Social Impacts; (iii) Proposed Management Measures; (iv) Technical and Operational Requirement of Management Measures; (v) Monitoring and Reporting; (vi) Implementation Plans and Institutional Responsibilities; (vii) Timeframe and (viii) Cost Estimates.

The Management Plans for both KHPP and JHPP included in the overall ESMP include: (a) Dam Safety Management Plan; (ii) Dam Safety Surveillance Plan; (iii) Dam Safety Emergency Plan; (iv) Dam Cost Recovery Plan; (v) Dam Sewage Management System; (vi) OHS Management System; (vii) Solid Waste Management Plan; (viii) Environmental Management System; (ix) Livelihood Support System; (x) Carbon Financing; (xi) Corporate Social Responsibility Policy. The consolidated ESMP is structured per project phase and includes the expected impacts, mitigation measures, monitoring and reporting requirements, responsibilities, timeframe and cost estimates of the various Management Plans.
Key risks include flooding of the communities in the affected areas. Mainstream Energy Solutions (Plc), the concessionaire for the two power plants will include a flood emergency planning unit within its hydrology department. The unit will work closely with the communities and government agencies to monitor potential flooding and implementation of the early warning system. A chief co-ordinator must be appointed and will be on call 24 hours a day during the flood season from July to October. At the community level, 228 flood warning posts for each of the affected villages and 92 flood demarcation posts in about 46 settlements to delineate the flood prone zone in Kainji and Jebba reservoir areas.

The key role-players during the rehabilitation works, for the purposes of environmental and social management on the sites, include but are not limited to: (i) The Developer (MESL); (ii) The Engineer; (iii) The main Contractors (direct appointments including civil works contractor, building contractor, landscape contractor etc.); (iv) The Environmental Control Officer (ECO); (v) Community Officer; (vi) Representatives of the relevant Federal and State Authorities; and (vi) AfDB or any lender that provides funding for the Project.

The total estimated cost for implementation of environmental and social management commitments (including monitoring) is estimated at US$ 2,689,363.00 for KainjiHPP and US$ 2,128,373.00 for Jebba HPP.

11. Institutional Capacities and Strengthening Plan

Institutional Capacities and Strengthening Plan
Mainstream Energy Solutions Ltd has worked towards building and generating the necessary capacity to implement the ESMP, which was followed by work done by SMEC to review the preparedness of the management and operations of the KHEPP and JHEPP to implement an internationally recognized Environmental Management System to ISO 14001:2004 and the allied social and economic components of the ESMP, as well as compliance status to ISO 9001 Quality Management Systems and OHSAS 18001 Occupational Health and Safety Management Systems. MESL has therefore adopted a standard policy and organizational model to ‘plan, do, act, review’ clear and measurable indicators that reflect the ability of an organization to establish and maintain systems and processes to implement environmental control and mitigation procedures (SMEC, EMS).

Management Structure
MESL has revised its organizational structure to include units and positions in the organization with roles, responsibilities and authorities for managing environmental aspects, action plans, programs and controls. All of these roles, responsibilities and authorities are documented. The company is focused on the competence, training and awareness of the relevant key staff managing the ESMP and associated plans and programs. Occupational Health and Safety (OHS) systems are being steadily introduced by Mainstream by the hydroelectric facility managing contractor at both Kainji and Jebba dam sites. The implementation is being initiated by senior management and a senior Health, Safety and Environment specialist has been engaged. The specialist has established HSE units and extended programs into the health sector as well. The MESL management structure in its design and operations takes cognizance of the need to properly oversee the environmental and social aspects of the company’s operation. The institutional arrangement taken by the company has seen the appointment of the QHSE Manager and a strong and effective OHS team.
The HSE Manager has appointed Environmental Managers at both sites along with complement relevant staff to oversee the implementation of an Operational Environmental Management Plan (OEMP). The approach adopted by MESL builds on existing successful activities and is likely to tackle and formalize a systematic response to major issues over the next two years. It is also complemented by professional development for HSE staff and senior management in environmental concepts, issues and systematic responses (SMEC, EMS).

Capacity building
The capacity of relevant staff has been strengthened through the ongoing establishment of an ISO compliant system and the associated registers of policies, procedures, issue map, monitoring tools, and reporting documents including training records and outlines of auditable activities. MESL staff and stakeholders involved in dam operation and management have also undertaken relevant capacity training. (SMEC, 2014), which included:

- The Consultant hydrologist, dam safety specialist and GIS specialist spent significant part of their input on dam sites working with counterpart staff.
- Formal classroom sessions were organized in Kainji on hydrologic modelling, flood mapping, dam data interpretation and dam safety plans.
- Two one-week workshops were organized by the World Bank, which focused on implementing interventions identified for dam operations and delivery of CSR to the riparian communities.
- A study tour to Australia was organized where the participants from various stakeholder institutions observed firsthand best practices in water resources management, dam operation, hydropower development and management. (SMEC, 2015).

The follow-up study by SMEC (2015) on Environmental Management System also provides a Responsibility Matrix, Training Needs Analysis and Training Plan that identified the responsibilities of individuals for managing environmental aspects and the environmental management system, and of individuals performing tasks that have a potential to cause a significant environmental impact, determine their competency, identify training needs, and plan for training (SMEC, EMS, 2015).

Human Resources
MESL has appointed a HR Associate to oversee the development of a wider HR Management System including staff records and monitoring. For effectiveness the Human Resources capacity will be strengthened through:

- Training for all staff directly responsible for the implementation of the Plan
- Establishing benchmarks and prepare a Training Matrix/ Training Needs Analysis
- Identifying gaps and critical training gaps
- Training for all staff directly responsible for the implementation of the WMP
- Training and sensitization in survey techniques, conflict prevention and key messages to survey team.
Community Livelihood Coordination

The Board of Directors and staff oversee the running of the foundation, which is funded by MESL. Training is also scheduled for the management and staff involved in the implementation of the CSR strategies (SMEC, CSR). In implementing the livelihood plan Mainstream will work with relevant stakeholders in the Kainji and Jebba Reservoirs Fisheries Centralized Coordination Committee (KJRFCCC): This will comprise of Kainji and Jebba communities representatives, government institutions (NIFFR – National Institute of Freshwater Fisheries Research, New-Bussa), National Park Authorities, Mainstream Energy Solutions Company, Marine Police, Federal Department of Fisheries, three states ADPs and Fisheries unit), State Ministry of commerce and industry and Sarkin and Ruwa traditional rulers.

12. CONCLUSION

The proposed rehabilitation project by Mainstream Energy Solutions Ltd. (MESL) entail rehabilitation and Capacity Recovery Plan (CRP) for the HPPs intended to re-establish the rated hydropower outputs, maintain and extend plants operations. The environmental and social review for the proposed Kainji and Jebba Hydropower Rehabilitation Projects therefore highlights that the projects will entail capacity recovery and rehabilitation works on already existing hydropower plants. The proposed rehabilitation project as shown by the reviews will have minimal negative environmental and social impact.

Although flooding is a recurrent phenomenon in the area, the SMEC reports on Jebba and Kainji Dams Safety Management Plan enumerate the responsibilities of the dam owner and dam operator and the regulatory authority of the government. Flood control and dam safety is consequently an issue that needs national action and inter-agency cooperation and is not the sole responsibility of MESL. The impact of implementing the project will however be beneficial. Rehabilitation will enable the plants to expand their generating capacity and contribute to meeting the energy requirements of Nigeria through sustainable renewable electricity generation. Not to proceed with the project will, thus, have far more serious costs to the environment and will minimize the opportunity to extend infrastructure serviceability and increase power outputs. The negative impact of non-rehabilitation would be a deterioration and breakdown of the plants with attendant adverse effects on electricity generation and social, environment and economic development.

Based on the consideration that rehabilitation will restore capacity, prevent plant deterioration, aid flood control and management, and provide additional electric power generation for Nigerians, adequate justification exists for the proposed project to be implemented.
13. REFERENCES AND CONTACTS

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- Dam Safety Emergency Plan (DSEP);
- Hydrologic Modelling and Flood Mapping (2014)
- Dam Safety Management Plan;
- Dam Safety Surveillance Plan;
- Corporate Social Responsibility (CSR) Plans;
- Environmental Management System (EMS)
- Occupational Health and Safety (OHS) systems;
- Dam Break FEWS (2014);
- Epidemiological Survey Report (April, 2015);
- Kainji Dam Project Monitoring Plan – Clean Development Mechanism;
- Sewage Management System;
- Solid Waste Management System;
- Livelihood Support Program (Fisheries Management Plan)

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