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LUEGERE HYDROPOWER PROJECT

BUSINESS PLAN

Prepared by

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List of Abbreviations and Acronyms

BRELA	Business Registrations and Licensing Agency
EBITDA	Earnings Before Interest, Tax, Depreciation and Amortisation
EBIT	Earnings Before Interest and Tax
EBT	Earnings Before Tax
EIA	Environmental Impact Assessment
EWURA	Energy and Water Utilities Regulatory Authority
IRR	Internal Rate of Return
Km	Kilometre
KV	Kilo-Volts (1,000V)
KVA	Kilo-Volt- Ampere (1,000VA)
KWh	Kilo-Watt -Hour (1,000Wh) = 1kWh= 1 electricity unit
KW	Kilo- Watt (1,000W)
Lv	Low Voltage
L/s	Liter per second
Mn	Million
M	Meter
M.a.s.l.	Meters above sea level
MW	Mega Watt
MWh	Mega -Watt- Hour
Mm	Millimeter
NEMC	National Environment Management Council
NPV	Net Present Value
RAP	Resettlement Action Plan
REA	Rural Energy Agency
SHEPP	Small Hydro Electric Power Project
SPPA	Standardized Power Purchase Agreement
TANESCO	Tanzania Electric Supply Company
TREEP	Tanzania Rural Electrification Expansion Project
TZS	Tanzania Shillings
USD	United States Dollar

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1.0 EXECUTIVE SUMMARY

1.1 Proposed business

Multiplex Systems Limited is an Engineering, Automation and Controls Systems Company founded in 2016 with the primary focus in Energy, Mining, Oil and Gas and Manufacturing Industries. Multiplex Systems – Energy division was established with the aim of developing runoff the river Hydropower projects across regions of Tanzania. Currently, Multiplex Systems Limited – Energy Division among other energy projects is developing the Luegere hydropower project of approximately 5.34MW at Luegere River in Rukoma village, Uvinza District, Kigoma Region. The off takers of the project will be TANESCO under SPPA.

The pre-feasibility study for the project revealed that the river has sufficient water flow throughout the year and sufficient head to generate electricity estimated to 5.34MW for the run-off-river scheme. The Environmental and Social Impact Assessment (ESIA) for the project also showed that the implementation of the project has less negative environmental impacts and it is expected to bring high social and economic development of the area.

1.2 Investment Cost and financing Structure

The total expected project investment is US$ 21,629,230 (around 54.57 Billion TZS). We propose a 70:30 debt-equity ratio for the project. Multiplex Systems Limited is seeking for a loan from financiers amounting to US$ 15,150,000; Grant of US$ 1,000,000 and US$ 5,479,230 as equity. We suggest this loan to be a 10 years loan with 2 years grace period and an interest rate of 6.5% per year. The loan we seek is a project loan secured by the underlying assets of the project. A summary of investment cost and financing structure is as shown in Table 1.1 and 1.2 respectively.

Table 1.1 Summary of Project Investment Cost

Cost Category	Million TZS	US$	%
Initial Setup Cost	3,469.13	1,375,000.00	6.36%
Generation cost			
Civil works:	29,172.94	11,562,800.00	53.46%
Equipment:	11,605.80	**4,600,000.00**	21.27%
Transmission cost	1,892.25	**750,000.00**	3.47%
Contingencies	3,686.81	**1,461,280.00**	6.76%
Working capital	4,743.62	1,880,150.00	8.69%

Grand Total CostEstimate	54,570.55	**21,629,230.00**	**100.00%**

Table 1.2 Financing Structure

Category	Million TZS	US$	%
Equity:	**13,824.10**	**5,479,230.00**	**25.3%**
Grants	**2,523.00**	**1,000,000.00**	**4.6%**
Loan	**38,223.45**	**15,150,000.00**	**70.0%**
Total Investment	**54,570.55**	**21,629,230.00**	**100.0%**

1.3 Project Returns

The project key return indicators are as indicated below:

Figure 1.1 Projected profit/loss for 16 years of the project

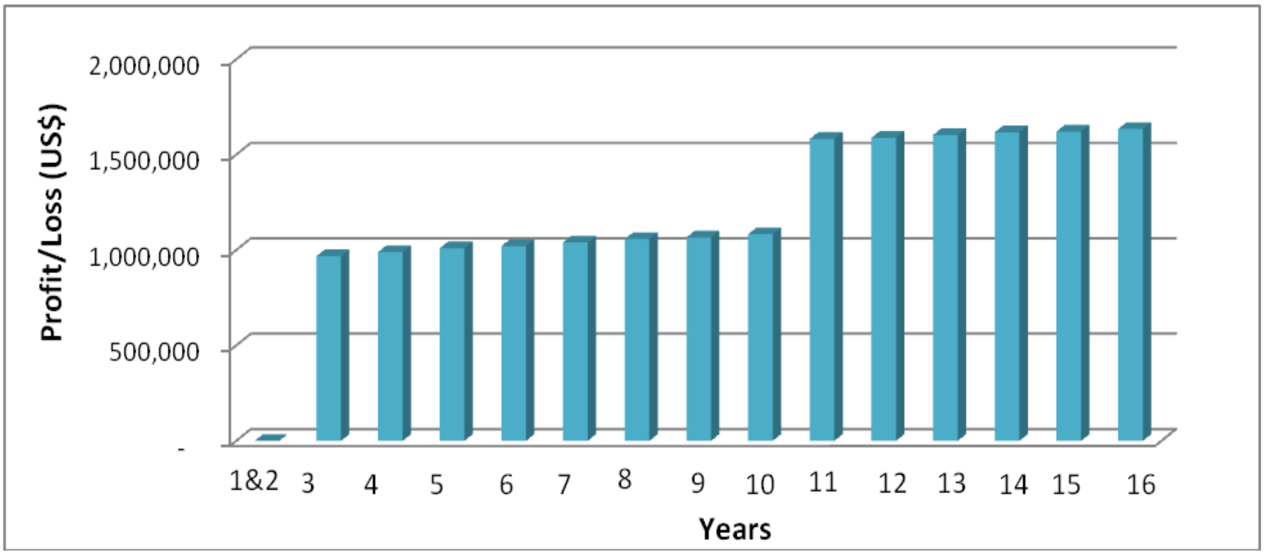


Table 1.3 Project Key Performance Indicators

Parameters	Base Case	Scn 1	Scn 2
NPV	598,146.106	516,919.88	233,232.48
Equity IRR	19.6%	19.0%	16.5%
DSCR	> 1	> 1	> 1
Payback period	7 Yrs 3 month	7 Yrs 4 month	7 Yrs 9 month
<u>Note:</u>	Base Case: Chosen scenario		
	Scn 1:Alternative scenario - increase of Opex by 10%		
	Scn 2: Alternative scenario - decrease of tariff by 10%		

1.4 Value Proposition

The availability of reliable and clean energy is the key driver for economic development of any country. In Tanzania, the energy coverage especially in peripheral areas is limited and this sets back economic development in the areas. There are several socio-economic activities in the rural areas that require availability of electricity for proper, smooth and beneficial functioning.

In view of the project area, the current power generation station in Kigoma region comprises of seven (7) diesel power generators in collaboration with the Solar Nextgen Company which together generates a total of 8.75MW. The TANESCO regional office of Kigoma revealed that the generated power does not sufficiently meet current and future power demands for the entire Kigoma region. Yet, many peripheral areas in the region have not yet reached with electricity; for instance 7 wards of Uvinza District comprising 28 villages nearby the proposed project site are not connected with electricity.

The energy sources for lighting for most of households in the project area are kerosene, dry cell battery, micro solar and car battery for radio and firewood for cooking. The energy sources for small enterprises such as milling, carpentry workshops, etc are diesel/gasoline powered machines which in principal costs a lot. Other important services like refrigeration and TV are limited due to lack of electricity. Very few people can afford this by the use of gasoline powered generator or solar power.

Therefore, this project aims to generate about 5.34MW and connect to the National Grid thereby contributing to the accessibility of reliable energy to the rural areas where the National grid is extending.

1.5 Business Model

Multiplex Systems Limited is a project developer that will manage all activities of the project development. Once shareholders are known and financial closure has been secured a new SPV company will be established to own and run the Luegere Hydropower Project after construction and commissioning. The SPV Company will have a project management team that will provide technical expertise, overall management and also monitor development and performance of the project during its lifetime. 100% of the energy generated will be sold to TANESCO Grid under SPPA at a tariff given by EWURA (the proposed tariffs under this business plan are 15cents USD per kWh during Debt Service period and 9.5cents USD per kWh after Debt Service period).

1.6 Management

The project development and implementation will be managed by the Project Development Manager, Mr. Thomas Kalunga (Engineering Energy) who will be assisted by experienced team of consultants in the energy sector particularly Hydropower projects as listed in section 3 of this business plan document (Table 3.1).

After construction and commissioning phase Multiplex systems limited in collaboration with the established SPV Company, will employ the required personnel. These will include but not limited to Managing Director, Accountant, Operations manager, Plant operators (Electrical & Mechanical), Office Secretary, driver and security guards.

1.7 Market Opportunity & Analysis

The current National energy policy promote and supports developers of small and min energy project to generate energy from the available potential sources such as biogas, wind, hydropower etc and connect to TANESCO grid whenever feasible or operate as isolated min grid and sale energy to communities around. The current power generation in Kigoma Region is 8.75MW. However, the generated power does not sufficiently meet current and future power demands for the entire Kigoma region. The region have 307 villages where 217 villages have connected by TANESCO grid and 90 villages including the 28 villages nearby the proposed Luegere hydropower project have not yet connected. Under such circumstances all power Luegere Hydropower Project can generate is urgently needed.

1.8 Business Objectives & Benefits

The overall objective of this project is to contribute to the country's programme on electrification coverage and poverty reduction by introducing hydropower to the area to enhance power availability for productive use and finally improving living standard through improved access to electricity for small-scale enterprises development and domestic uses.

The project is considered to have positive development impacts for both domestic and business activities in the region. For instance, there are several potential business enterprises in the region such as grain milling machines, sunflower oil processing, carpentry workshops, shops, restaurants etc. which at the moment are using energy produced from fossil products which is quite expensive. Availability of power from the intended project will be the redeemer of the communities from that burden.

1.9 Exit Strategy

Multiplex Systems Limited is developing and will implement the project in partnership with reputable consultants, contractors and potential investors and development grants partners active on African continent. Once shareholders are known and financial closure has been secured a new SPV company will be established to own and run the Luegere Hydropower Project throughout its lifetime.

2.0 INTRODUCTION

2.1 Project background

Multiplex Systems Limited (MSL) is the Developer of Luegere Hydropower project. MSL is a legal registered limited company under the companies Act, 2002 with registration No. 126637 given on 25th May, 2016. The principal activity of the Company is to carry out the business of Engineering, Automation and Technology with the primary focus in Energy, Mining, Oil and Gas and Manufacturing Industries. Multiplex Systems – Energy division was established with the aim of developing runoff the river Hydropower projects across regions of Tanzania.

In line to its goals, Multiplex Systems Limited – Energy Division among other energy projects is developing the Luegere hydropower project of approximately 5.34MW at Luegere River in Rukoma village, Uvinza District, Kigoma Region. The off takers of the project will be TANESCO under SPPA. The overall objective of this project is to contribute to the country's programme on electrification coverage and poverty reduction by introducing hydropower to the area to enhance power availability for productive use and finally improving living standard through improved access to electricity for small-scale enterprises development and domestic uses.

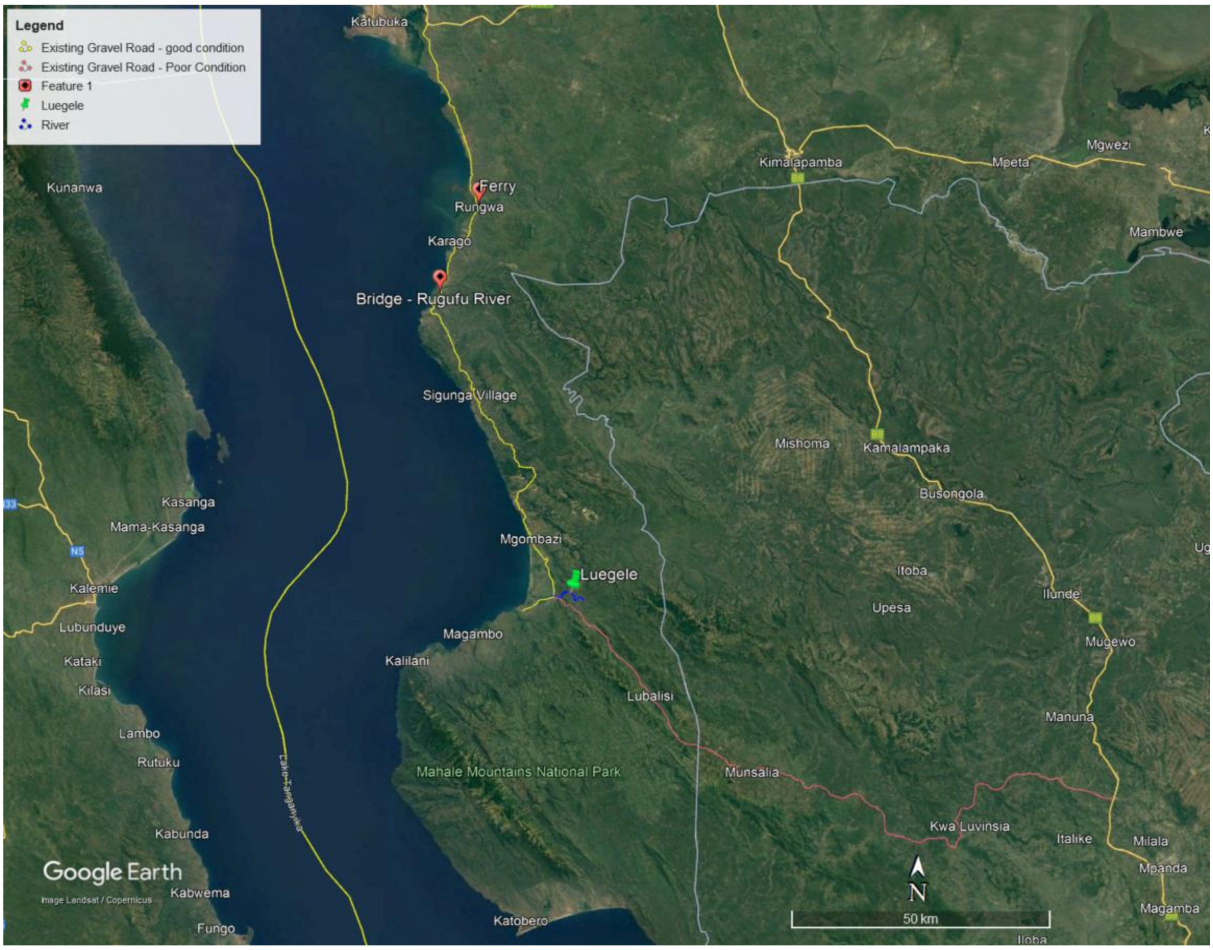
The proposed project will harness the existing and unutilized potential (water fall) at Luegere River, to produce clean and environmentally friendly electricity and supply reliable electricity to TANESCO Grid. This will subsidize the current use of Diesel generators and reduction of air pollution.

A pre-feasibility study conducted revealed that the river has sufficient water flow throughout the year and sufficient head to generate electricity estimated to 5.34MW for the run-off-river scheme. The Environmental and Social Impact Assessment (ESIA) for the project also showed that the implementation of the project has less negative environmental impacts and it is expected to bring high social and economic development of the area.

2.2 Project Location

The proposed Luegere Hydropower Project is located along Luegere River, Malagarasi and Lake Tanganyika River Basin, nearby Rukoma village, Kigoma Rural district, Kigoma region. The river is a tributary of the Lake Tanganyika. The site is located 130km south of Kigoma. The intake is about 2000meters above sea level. Access to the site is possible by taking a good dirt road up to Rukoma village. Before reaching the village, a dirt road leads to the left bank of the Luegere River. From there, the proposed weir location is accessed with a 3km long track.

Figure 2.1 Luegere HPP Location



The coordinates of the proposed intake weir, forebay and power house are:-

Intake – 985 masl	**Forebay – 980 masl**	**Powerhouse – 800 masl**
Lat: 5°53'41.69"S	Lat: 5°53'44.13"S	Lat: 5°54'4.71"S
Long: 30° 1'45.12"E	Long: 30° 1'14.34"E	Long: 30° 0'39.23"E

drive including ferry crossing) from Kigoma on route towards the Mahale Mountain National Park (note – the project is well outside the park border). It is understood that plans to upgrade the existing gravel road between Mpanda and Rukoma have been tabled by the respective District Commissioner, which would greatly improve trade between the Kigoma, Rukwa and Mbeya Regions as well as haulage distance of materials and equipment during construction.

The existing gravel road between Kigoma and the project site is in good condition and runs in close proximity to the proposed project site, with access to the proposed Luegele Powerhouse several hundred meters away from the main access road. It is understood that the Rural Energy Agency (R.E.A) planned 33 kV feeder to be constructed along the coast is underway. The proposed Malagarasi HPP (TANESCO) consists of a 50 km 132 kV transmission line to the Kidahwe 400/132/33 kV substation.

The distance between Mpanda and Kigoma is approximately 300 km (5 hr drive). The gravel road portion between Mpanda and Uvinza is currently in good condition and is planned to be upgraded to a surfaced road. The remainder of the road between Uvinza and Kigoma is surfaced.

2.3 Value Proposition

The availability of reliable and clean energy is the key driver for economic development of any country. In Tanzania, the energy coverage especially in peripheral areas is limited and this sets back economic development in the areas. There are several socio-economic activities in the rural areas that require availability of electricity for proper, smooth and beneficial functioning.

In view of the project area, the current power generation station in Kigoma region comprises of seven (7) diesel power generators in collaboration with the Solar Nextgen Company which together generates a total of 8.75MW. The TANESCO regional office of Kigoma revealed that the generated power does not sufficiently meet current and future power demands for the entire Kigoma region since the districts of Buhigwe, Uvinza, Kigoma urban and Kigoma Rural equaly depend on power generated from the same Kigoma power station. Yet, many peripheral areas in the region have not yet reached with electricity; for instance 7 wards of Uvinza District comprising 28 villages nearby the proposed project site are not connected with electricity.

The energy sources for lighting for most of households in the project area are kerosene, dry cell battery, micro solar and car battery for radio and firewood for cooking. The energy sources for small enterprises such as milling, carpentry workshops, etc are diesel/gasoline powered machines which in principal costs a lot. Other important services like refrigeration and TV are limited due to lack of electricity. Very few people can afford this by the use of gasoline powered generator or solar power.

Considering the need to improve the socio-economic situation in the region, Multiplex Systems Ltd has decided to take a serious investment to the proposed project to contribute to the National programme on electrification coverage.

Therefore, this project aims to generate about 5.34MW and connect to the National Grid thereby contributing to the accessibility of reliable energy to the rural areas where the National grid is extending.

3.0 BUSINESS MODEL

3.1 Legal ownership

Multiplex Systems Limited is a project developer that will manage all activities of the project development. Once shareholders are known and financial closure has been secured a new SPV company will be established to own and run the Luegere Hydropower Project after construction and commissioning. The SPV Company will have a project management team that will provide technical expertise, overall management and also monitor development and performance of the project during its lifetime. 100% of the energy generated will be sold to TANESCO Grid under SPPA at a tariff given by EWURA (the proposed tariffs under this business plan are 15cents USD per kWh during Debt Service period and 9.5cents USD per kWh after Debt Service period).

3.2 Management and Manpower

3.2.1 Project Development Senior Management Team

The project development and implementation will be managed by the Project Development Manager, Mr. Thomas Kalunga (Engineering Energy) who will be assisted by experienced team of consultants in the energy sector particularly Hydropower projects as listed in Table 3.1.

Table 3.1Project development and implementation management team

Name & Title	Expertise & Role in the project
Mr. Thomas Kalunga	Engineering Energy - Project Dev. Manager
Mr Michele Reolon	Civil Engineering - Project Consultants Team Leader
Mr. Francis Songela	Renewable Energy - Projects Engineering Consultant
Mr. Ryan Thomson	Energy Development Consultant
Ms Ghanima Chanzi	Water Resources Engineer/Hydrologist
Mr Nicolò Doglioni	Geologist/Engineering Geologist
Mr Hans Lottering	Electrical Engineer
Mr Martino Dal Farra	Drone Surveyor /Geotechnical Engineer
Mr Eugenio De Demo	Civil Engineer
Mr Giuliano Cavarzan	Hydraulic/ Hydropower Engineer
Mr Andrea Ciriaco	Electro-Mechanical Engineer
Mr. Malimi L. Sitta	Economist – Business Consultant

3.2.2 Project staff after commissioning

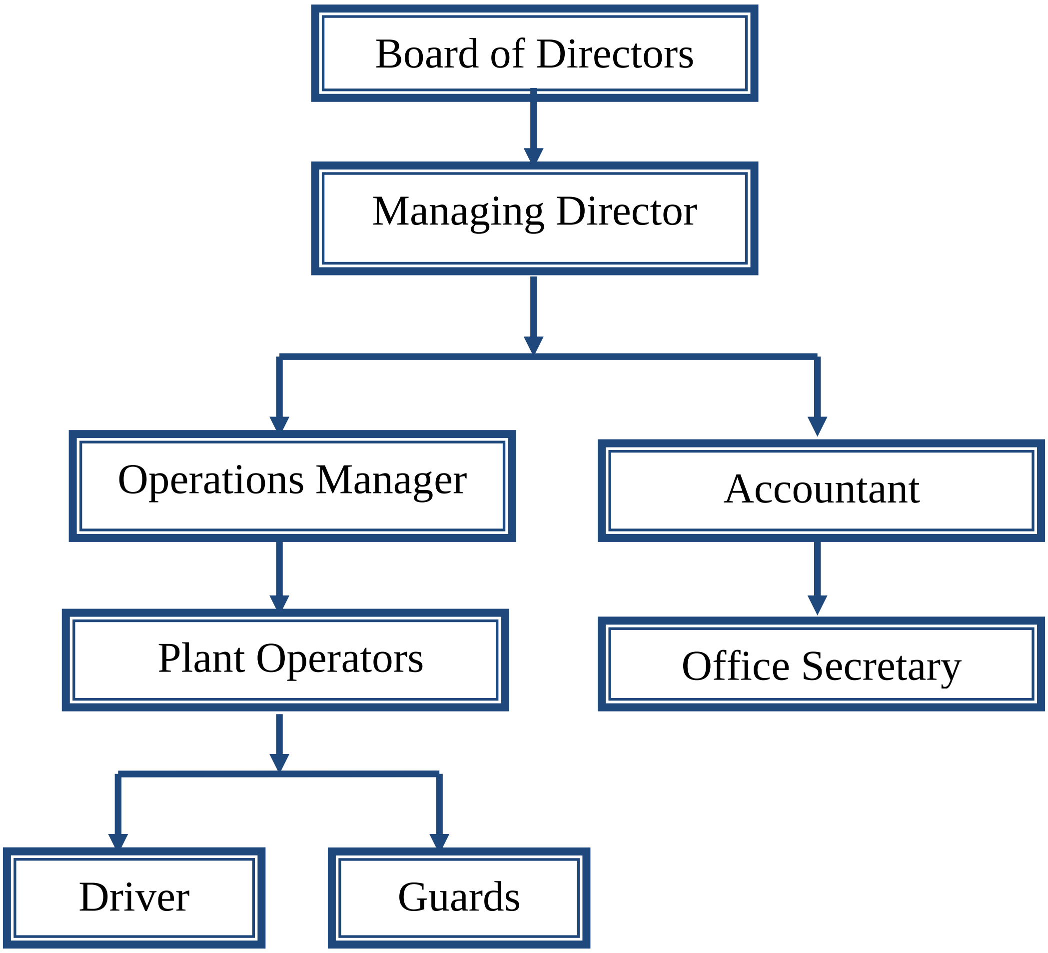
After construction and commissioning phase Multiplex systems limited in collaboration with the established SPV Company, will employ the required personnel. These will include but not limited to Managing Director, Accountant, Operations manager, Plant operators (Electrical & Mechanical), Office Secretary, driver and security guards.

1. Managing Director: at the last year of project construction
2. Operations manager: at the last year of project construction.
3. Accountant: After project commissioning
4. Three (3) Plant Operators (Mechanical/electrical): one at last year of project construction and two after project commissioning.

5. Three (3) Guards: two during project construction, a third after project commissioning.
6. Office Secretary: after project commissioning.
7. Driver: after project commissioning.
8. Security guards: after project commissioning.

3.2.3 Proposed organization chart

The proposed SPV Company for Luegere Hydropower project will have the following organization chart.



4.0 INDUSTRY AND MARKET ANALYSIS

The current National energy policy promote and supports developers of small and min energy project to generate energy from the available potential sources such as biogas, wind, hydropower etc and connect to TANESCO grid whenever feasible or operate as isolated min grid and sale energy to communities around. The current power generation in Kigoma Region is 8.75MW. However, the generated power does not sufficiently meet current and future power demands for the entire Kigoma region. The region have 307 villages where 217 villages have connected by TANESCO grid and 90 villages including the 28 villages nearby the proposed Luegere hydropower project have not yet connected. Under such circumstances all power Luegere Hydropower Project can generate is urgently needed.

5.0 TECHNOLOGY

5.1 Type of scheme

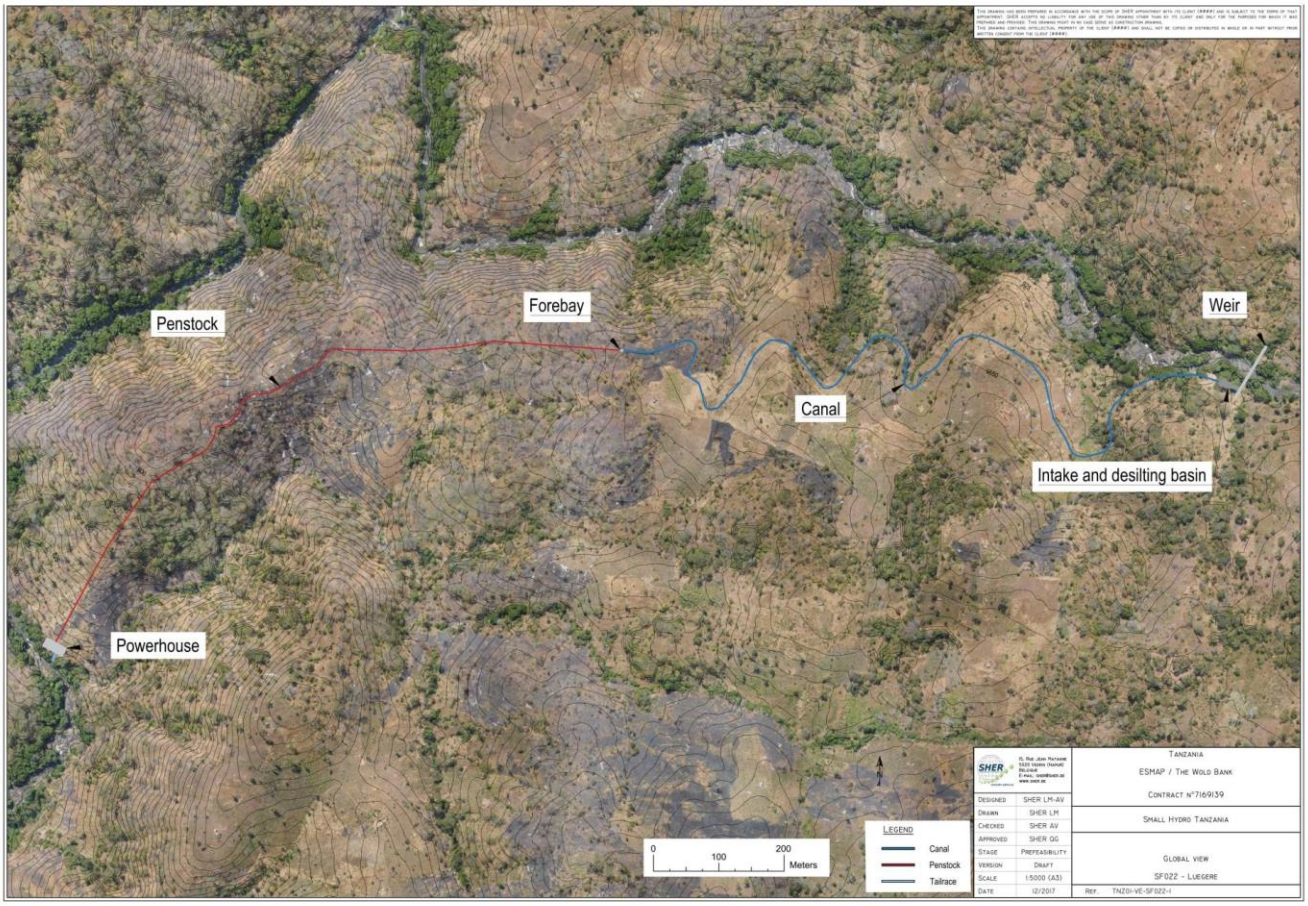
The Technology to be used is Hydro Electric Power generation "Run -of-River" system without regulation capacity with head works consisting of weir, intake & desilting basin, canal, forebay, penstock, power house Station and Electricity transmission Network.

5.2 Diverting structure, intake, waterway and powerhouse

The intake structure, waterway and power plant will be located on the left bank of the river. The diverting structure (consisting of a weir) is located on the bedrock of the river. This position allows setting a 50-m long overflowing weir and minimizes the water level over the crest during exceptional floods. It is followed by a small waterfall 100m behind the weir, which should ensure that headrace canal is above flood level. The natural river slope behind the weir also allows desilting basins to flush properly the accumulated sediments. The access to the intake and the desilting basin will require a crossing bridge over the weir.

The weir is equipped with a gated flushing channel to prevent the accumulation of sediments in front of the intake and the weir. A 1 420m long headrace canal (rectangular section) will convey the water from the intake structure (including a desilting structure) to the forebay. The intake and the waterway are designed to minimize the head losses. The 1 110m long pressure penstock will convey the water from the forebay to the hydroelectric power plant located on the left bank of the river, above extreme flood level.

Figure 5.1 Detailed proposed scheme and main components



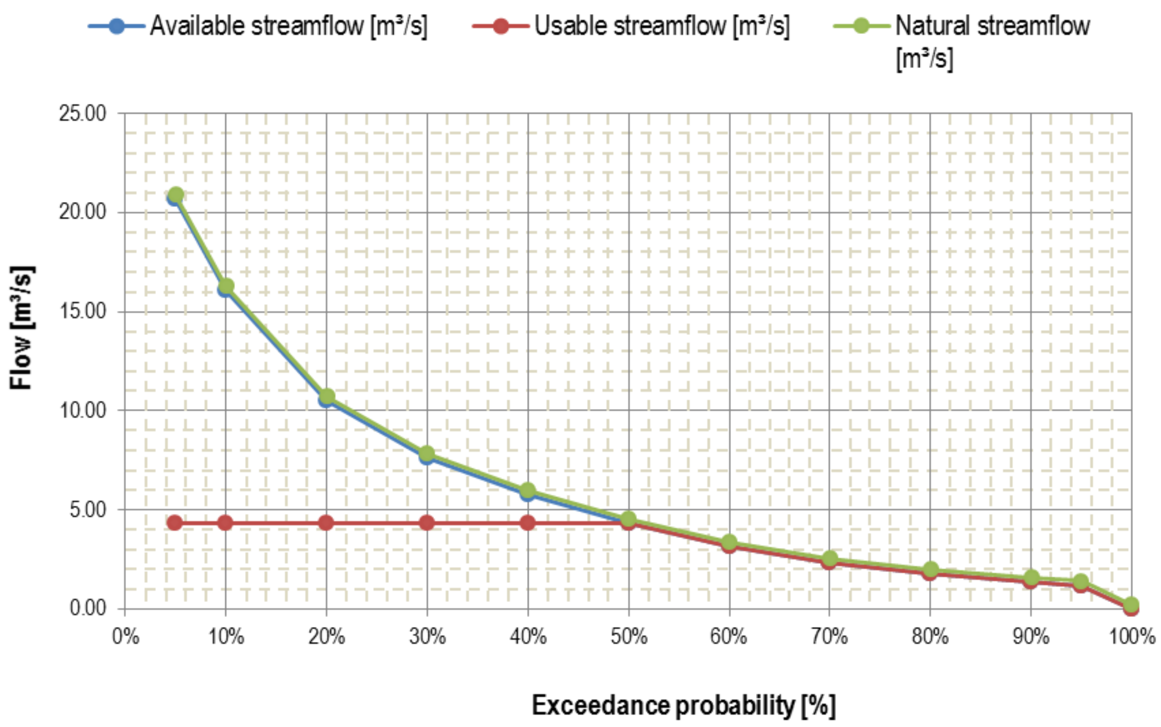
5.3 Design flow

The Luegere River will be by-passed over a length of approximately 3.2 km. An environmental flow guaranteed at all times is required for environmental and ecological reasons. In the absence of commonly agreed international standards and given the uncertainties on the available stream flow of the river, the ecological flow is set at 230 L/s, which corresponds to 5% of the median flow (Q50%) of the river in natural conditions. Since this flow is not available for the turbines, it is necessary to subtract it from the flow duration curve of the river.

The flow duration curve that can actually flow through the turbines is finally obtained by considering the design flow rate of equipment chosen at the pre-feasibility stage, namely 4.33 m^3/s. The usable flow duration curve is illustrated in Figure 5.2 below.

The final choice of design flow will be made at the feasibility study stage based on an economic analysis of alternatives. The flow duration curve must also be validated by the additional hydrological analysis and measurements.

Figure 5.2 Usable flow duration curve of the Luegere River at the project location



5.4 Structures Design

5.4.1 Diverting structure type and characteristics

Given the nature of the foundations as well as the estimated water head on the diverting structure for the design flood, a concrete gravity-overflow weir is the most appropriate structure. A concrete structure is also particularly recommended for submersible structures. This choice is motivated by the following elements:

- The local geology shows that the rock is of good quality, adapted to the foundations of a concrete weir;
- Given the magnitude of the design flood, the weir must be as low as possible in order to minimize the impact of the upstream water level rise;
- An ungated weir/spillway will be easier to build and safer in design since there is no risk of dysfunction or misoperation of the gates, particularly during flood events.

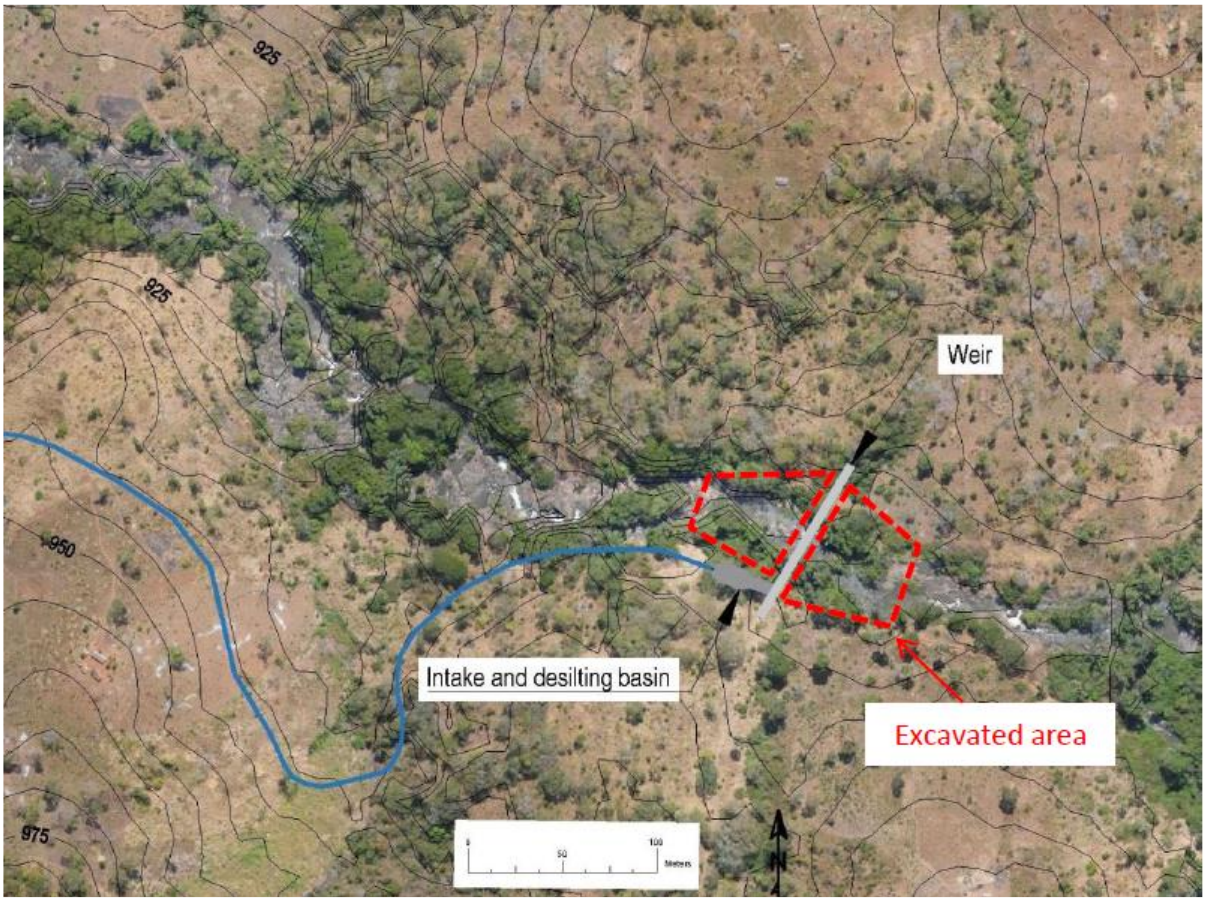
The crest length will be 50m, which limits the water level over the crest during floods. The weir will be equipped with a gated flushing channel on the left bank to flush the sediments that would have accumulated in front of the water intake. The main features of the weir are presented in Table 5.1.

Table 5.1 Weir Key Features

Parameter	Value	Unit
Weir type	Gravity Creager overflowing section	
Material used	Concrete	
Overflowing crest length	50	m
Total weir length	70	m
Overflowing section height	4.50	m
No-overflowing section height	7.15	m
Crest elevation	943.00	masl
Slab elevation	938.50	masl

In order to obtain a 50-m overflowing crest length, excavation on both side of the river are needed. It is recommended to reshape the riverbanks upstream and downstream of the weir in order to remove the accumulated sediments and improve the hydraulic conditions for the intake and overflowing weir. The approximate area to be reshaped is illustrated in **Figure 5.3**

Figure 5.3 Appropriate area to be reshaped upstream and downstream the proposed weir location



5.4.2 Temporary diversion

The purpose of the temporary diversion is to dry up part of the river to allow the construction of the weir and appurtenant structures described in the previous section. The temporary diversion will be implemented consecutively on the left bank in order to construct the gated flushing channel and the intake, then on the right bank. It will consist of a compacted embankment cofferdam or, if the ground conditions are favorable, sheet piles.

5.4.3 Outlet structures

The outlet structure consists in a gated flushing channel. It is designed to allow inspection of the weir and intake. In addition, the outlet structure while open can create a strong current with the effect of flushing the accumulated sediments close to the intake structure.

The flushing channel will be equipped with gates of which the invert is positioned at an elevation close to the elevation of the natural riverbed. The gates will be located on the left side of the weir, next to the intake structure to allow an effective flushing of the accumulated sediments. The number of bays and their size were calculated to ensure outflow corresponding to twice the $Q_{30\%}$ stream flow of the river (15.66m³/s). This objective is achieved with the installation of two 1.40m wide and 1.50m high radial gates.

5.4.4 Intake structure

The intake will be located on the left bank in the continuity of the weir. The intake will also be equipped with a screen and a manual screen cleaning system upstream of the intake gates, to prevent floating debris or large stones from obstructing the intake gates. The section of the bars and their spacing will be determined at the feasibility study stage. The intake is designed taking into account the following constraints:

- The invert elevation will be set 2.50m above the invert of the flushing gates;
- The velocity of water at the entrance of the screen should not be greater than 0.7 m/s to minimize turbulence and facilitate screening of debris. That will also minimize head losses.

Hence, the intake will consist of 2 bays of 2.00m wide and 2.00m high, followed by a free inlet that will guide the current lines gradually towards the desilting structure. The invert of the intake will be set at elevation 941m. Details are presented in Table 5.2 hereafter.

Table 5.2 Intake characteristics

Parameter	Symbol	Unit
Intake invert elevation	masl	941
Intake top elevation	masl	943
Screen inclination	°	15
Design flow	m³/s	4.33
Number of bays	-	2
Bay width	m	2.20
Bay height	m	2.00
Type of gate	-	radial
Flow velocity at intake	m/s	0.7

5.4.5 Desilting structure

Solid transport is expected to be high, especially during the wet season. Consequently, the intake and desilting structures must be adequately designed to ensure the removal of the problematic sediment load before entering the headrace canal. The sediments that would accumulate in front of the intake will be flushed by frequent flushing operations using the flushing gates designed for this purpose. The inlet of the desilting structure will have a sufficient slope in order to guide the solid particles to outlet of the basins. Moreover, the desilting basins will be long enough to ensure particle settling.

The desilting structure will be composed of 2 sub-basins each 4.5m wide and will have a sedimentation length of 19.25m. To this must be added the transition zones upstream and downstream of the settling tank of the desilting structure. The desilting structure will therefore have a total length of 21.75m and a total width of 10.50m and a maximum depth of 3.00m.

5.4.6 Headrace canal

The canal features a rectangular cross-section of 2.00 m in width for a water height of 2.00 m, to which is added a freeboard of 30cm, which results in a total height of 2.30 m. The headrace canal is 1420m long.

5.5 Penstock

The headrace canal and the pressure penstock meet at the forebay. The forebay will be equipped with a scour gate in order to drain the channel as well as the particles that would have sedimented in the latter back to the river. The forebay will be equipped with a safety spillway in the event of excessive inflows coming from the headrace canal or allowing the spill of the water in excess during variations flow through the turbines (production decrease, shutdown of a group, etc).

The pressure steel penstock will be over-ground and 1110m long. The penstock will be supported by reinforced concrete support blocks. The distance between two support blocks is 6m. Anchoring blocks will be placed at each elbow to balance the forces related to the change of direction of the flow. In order to limit the head losses to a maximum of 8% of the gross head, the penstock will have a diameter of 1.20 m.

5.6 Electromechanical Equipment

The pre-feasibility study considered 3 units of Pelton turbine and the highest rotational speed is preferred. The main characteristics and dimensions of the equipment are as shown in Table 5.3 and Table 5.4 respectively:

Table 5.3 The main characteristics of the equipment

Turbine type		Pelton
Number of turbines	(-)	3
Nominal turbine discharge	m3/s	1.443
Minimal turbine discharge	m3/s	0.087
Net head (at Qn and with all the turbines))	m	147.6
Rotation speed	rpm	600
Number of nozzles	-	5 or more
Max. Turbine efficiency	(%)	≈ 90.5%
Max. Generator efficiency	(%)	≈ 94.9%
Power Factor	(-)	0.9
Generator Apparent Power	kVA	≈1’980
Generator Power	kW	≈1’780
Generator voltage	kV	≥ 0.4

Table 5.4 The preliminary main dimensions of the 3 Pelton units

D1	Pitch diameter	m	0.81
Dc	Casing diameter	m	2.88
Ha min	Minimal height between the medium plan of the runner and the downstream water level	m	1.85
Hab min	Minimal height between the ceiling of the tailrace channel and the runner axis	m	1.45
Hb min	Minimal height between the medium plan of the runner and the top of the casing	m	0.60
DD	Diameter at the inlet of the turbine manifold	m	≈0.80
L1	Length L1 of the turbine manifold	m	2.7
L2	Length L2 of the turbine manifold	m	2.7
W1	Width W1 of the turbine manifold	m	2.7
W2	Width W2 of the turbine manifold	m	2.4
DG	Diameter of the generator	m	1.5
HG	Height of the generator	m	2.5
WG	**Weight of the generator**	**t**	**12**

The hydro and electromechanical equipment of the powerhouse includes:

- Three security valves, spherical or butterfly type, equipped with counterweight as an emergency closing mechanism in the event of the loss of the grid
- Three Pelton turbines
- Three low voltage synchronous generators
- Three Step Up LV/MV transformers and the connection to the MV switchboards
- The cabinets for control and monitoring systems, included the speed and voltage regulators, metering and relaying panels for each unit
- The power plant control and monitoring cabinet
- The cabinets for Low Voltage distribution
- The Electrical protections and safety systems
- One auxiliary LV transformer
- One DC power supply and an Emergency diesel auxiliary power generator
- Earthing and Lighting system with their protection

5.7 Powerhouse

The hydropower plant will be positioned on the left riverbank. A truck access road should be provided to allow the delivery of the turbine / generator units. A platform will also have to be constructed to allow the maneuvering of long vehicles. The power plant floor elevation is chosen so as to ensure that it remains above flood level. The tailrace canal will discharge the turbined outflow to the river downstream of the power station. It will have a length of 10m.

The plant will consist of 3 + 1 bays, one per unit and one bay for assembly/dismantling. One floor is provided for offices, toilets, control room and meeting room. The area under the offices will allow the storage of tools and spare parts. A backup generator will also be placed there. The height of the plant will be governed by the size of the highest of the parts to be handled and by the characteristics of the crane. The dimensions of the plant, estimated at 15m wide, 35m long and 13m high, will have to be refined in subsequent studies. For safety reasons (fire hazard) the transformers will be positioned in the immediate vicinity of the plant in a separate room.

5.8 Electricity Transmission Network

The main transmission Aluminum Cable Steel Reinforced (ACSR) overhead power line will be approximately 4km to the expected TANESCO grid. It has been designed to carry all of the power that can be generated and has the capacity to carry any further future generation upgrades that may wish to be done at this site.

The vertical conductor configuration (stand-alone) type of transmission with earth grounding system at 10^{th} to 20^{th} pole will be employed to protect backbone line from lighting effect. The wooden type of pole is recommended because of easy availability and the hilly topographical of the project area will not allow accessibility of heavy machines during erection. The span length between poles for HT lines is 100m to 120m. Length of HT poles should be between 11m and 13m depending on the geographical condition of the project area.

The location of supporting structures should be among other things selected at places where easy to access and maintenance. Poles are not set around steep slope or at bottom of a cliff; the safer route has to be taken into account which will avoid erecting of poles at the bottom of cliff. If a connection has to be made between aluminium and copper conductors, bimetallic connectors (PG connectors) designed for this purpose must be used. These provide adequate separation between the conductors to prevent electrolytic attack on the aluminium conductor. Even then, it is good practice to install the aluminium conductor above the copper conductor if possible. This will prevent pitting of the aluminium conductor due to copper salts being washed over the aluminium.

6.0 HYDROLOGY

6.1 Physical Context

The Luegere River originates in the Katavi region at elevations over 2,000 m. The Luegere River flows mainly from the Southeast to the Northwest and discharges into the Lake Tanganyika about 10 km downstream to the hydroelectric project.

As shown in Figure 6.1, the Luegere catchment at the proposed hydroelectric project site features a marked relief with elevations between 2,036 m and 976 m (1,420 m on average). The drainage basin of the Luegere River at the proposed intake site is 1,317 km² (delimitation based on the SRTM DSM of spatial resolution 1 arc-second, i.e. approximately 30 m). The main physical and morphological features of the river catchment are presented in Table 6.1 below.

The hypsometric curve of the river catchment is shown in Figure 6.2. This curve shows the percentage of the catchment area above a given elevation. It shows that slopes are important in the upstream part of the catchment and that the rest of the catchment flows on a plateau characterized by a relatively steep slope. This is clearly observed in Figure 6.1 and Figure 6.2

Table 6.1 Physical and morphological characteristics of the catchment

Parameter	Value	Unit
Area	1,317	km²
Average elevation	1,420	m a.s.l.
Maximum elevation	2,036	m a.s.l.
Maximum elevation (percentile 5%)	1,751	m a.s.l.
Minimum elevation	976	m a.s.l.
Minimum elevation (percentile 95%)	1,105	m a.s.l.
Slope index	8.6	m/km
Elevation range	646	m
Perimeter	271.8	km
Gravelius index	2.10	-

Figure 6.1 Luegere River catchment and digital surface model

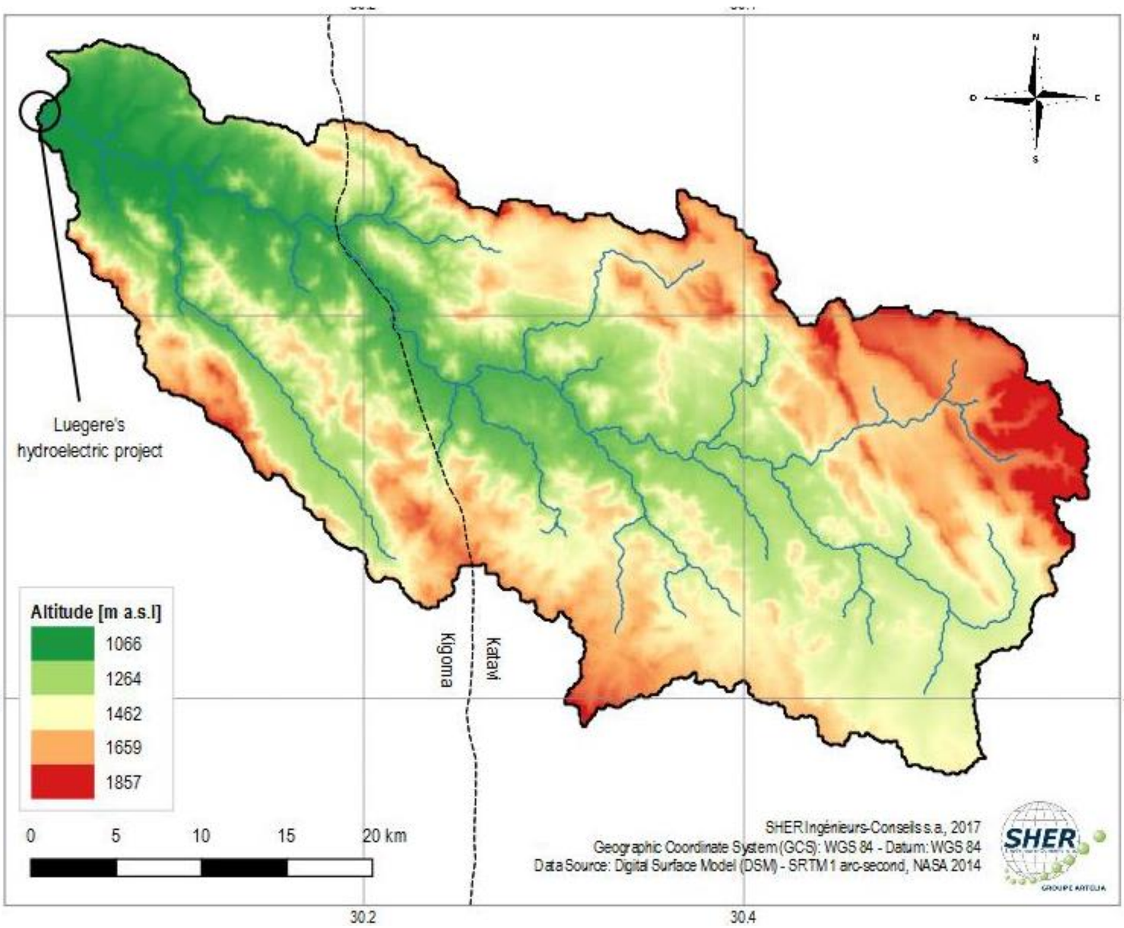
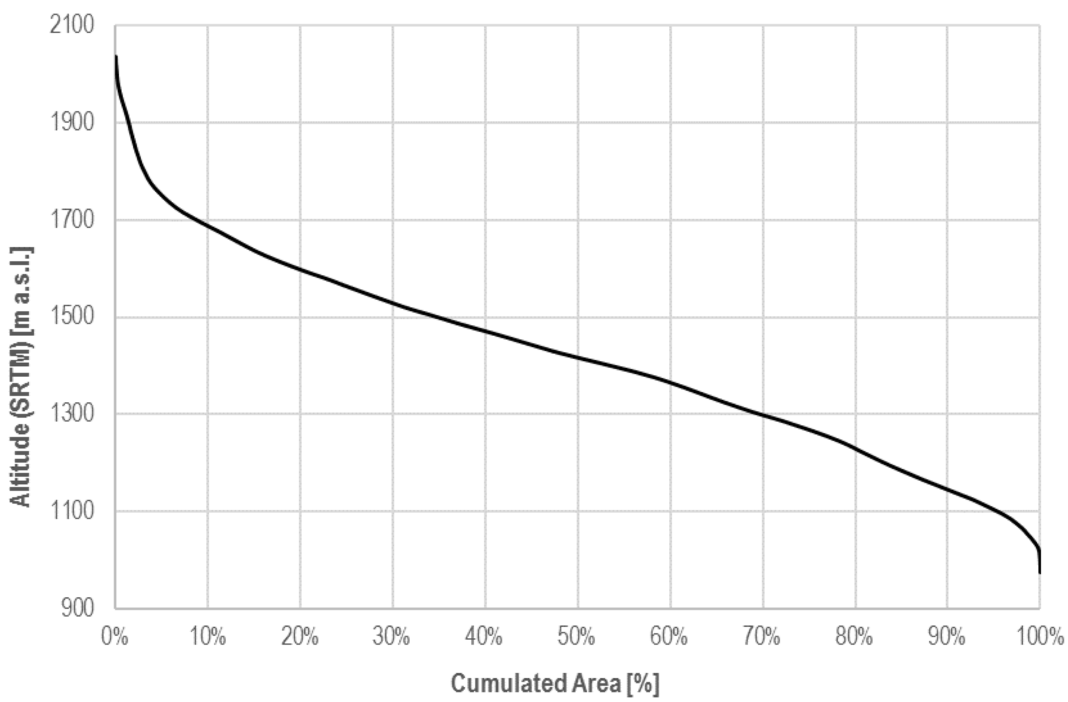


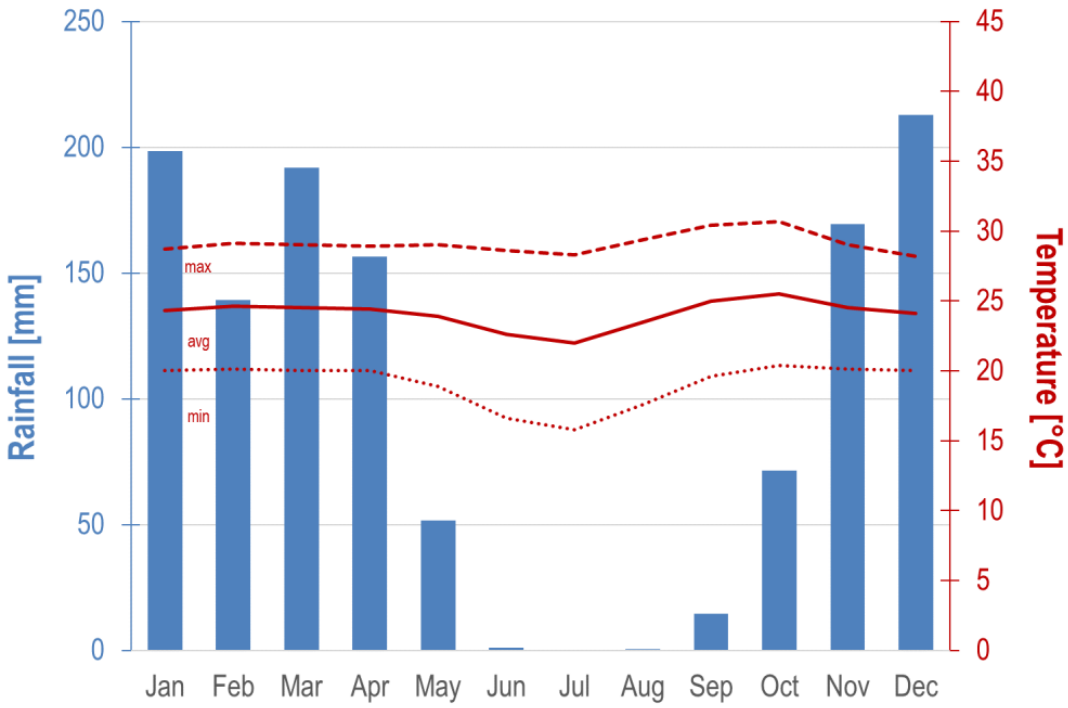
Figure 6.2 Hypsometric curve of the Luegere River catchment



6.2 Climate

The project area (Luegere River catchment) is characterized by a tropical savanna climate with a pronounced dry season and constant high temperatures. Figure 6.3 shows the climatic diagram as well as the temperature curve for the Luegere River watershed. Precipitations are very low during the dry season (June to September) but significant during the wet season. July is the driest month without precipitation (on average) whereas the wettest month is December with 213 mm on average. The average annual precipitation is 1,208 mm.

Figure 6.3 Climatic diagram of the Luegere River catchment



It is observed that the average annual temperature is 24.1°C. Temperature does not vary much throughout the year with average amplitude of 3.5°C. The warmest month is October with 25.5°C and July is the coldest, with an average temperature of 22.0°C.

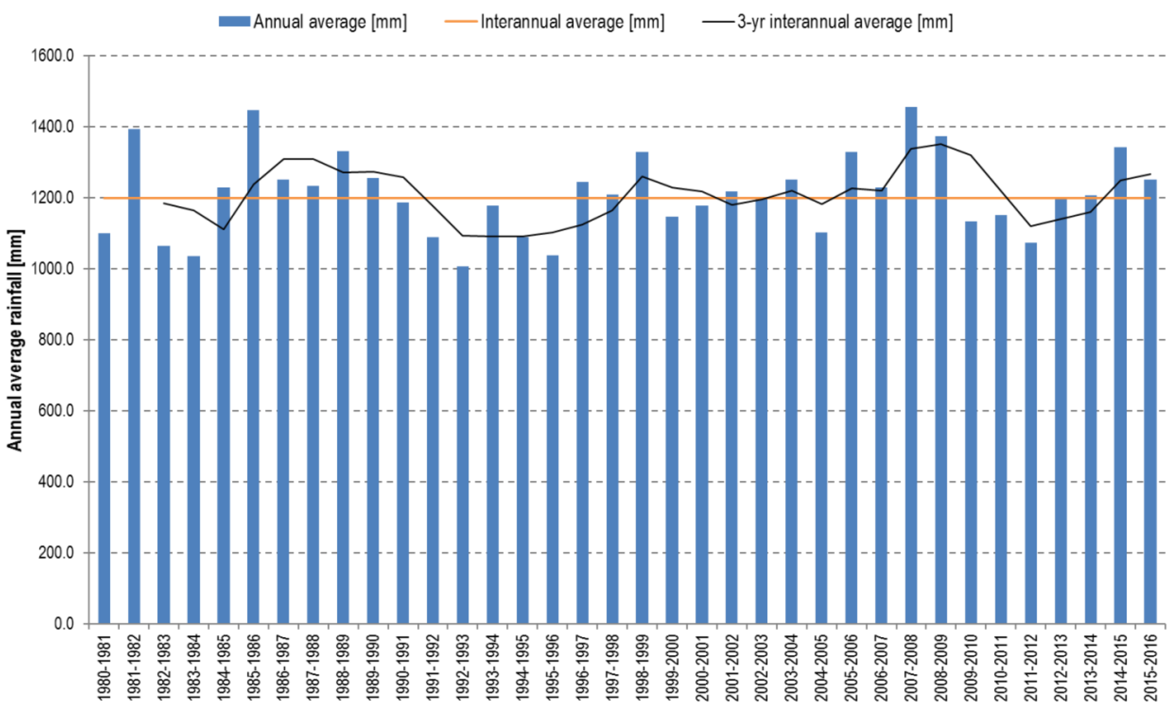
6.3 Hydrological data

An existing stream flow monitoring station (ref: Luegere River at Lubalisi, 4D1) is located 2 km downstream the hydroelectric project. Data have been collected in the Lake Tanganyika Water Basin Office. The completeness of the time-series (12% of daily data gap, 1975-1988) is not sufficient for a reliable statistical analysis.

To estimate the stream flows of the Luegere River at the hydroelectric project, a method based on the generation of synthetic stream flows on the basis of precipitation data through hydrological modeling was developed. The spatial variation of average annual rainfall within the watershed is significant with a minimum of 1,056 mm in the northwestern part of the catchment and a maximum of 1,283 mm in its northern part.

The temporal variation in rainfall for the Luegere catchment has been studied from CHIRPS dataset (period 1981-2017) and the results are presented in the graph below. Annual average is fluctuating between 1,000 mm and 1,400 mm but it does not feature any clear trends in annual patterns.

Figure 6.4 Temporal variation in rainfall for the Luegere catchment



6.4 Flow duration curve

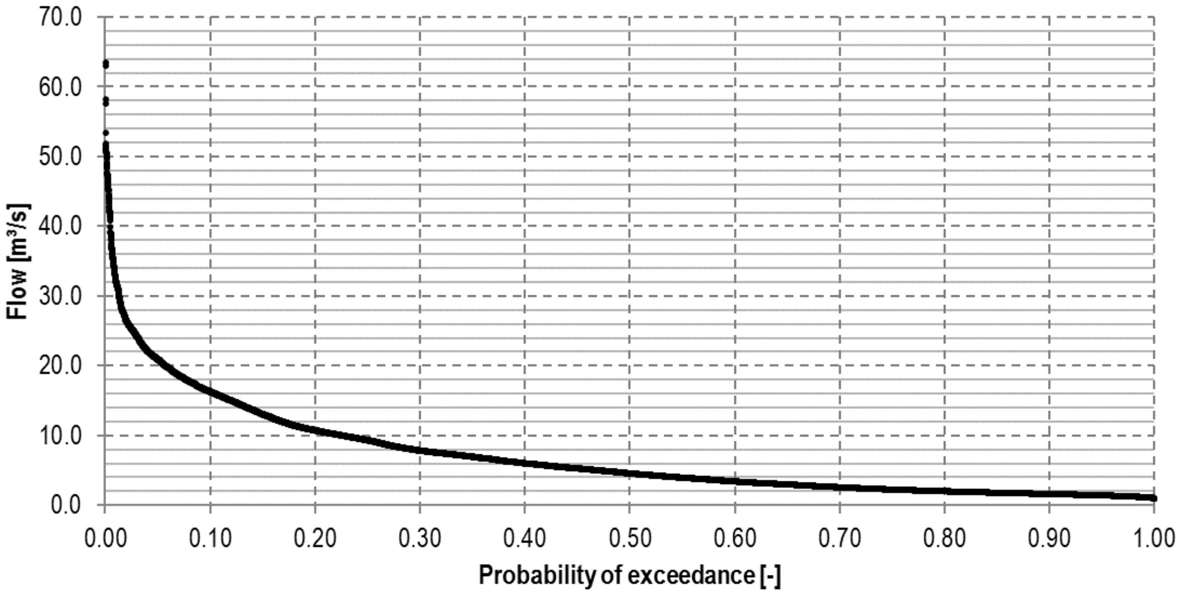
Among the hydrological parameters, the determination of the flow duration curve is essential to know the availability of the flows in the river for the hydroelectric project. Indeed, this curve shows the percentage of time that the stream flow in a river is likely to equal or exceed some specified value of interest.

Table 6.2 and Figure 6.5 show the modelled flow duration curve as well as the main percentiles. The proposed model shows that the stream flow of the Luegere River at the hydroelectric project is less than 12.0 m³/s 50% of the time and that it is higher than 26.8 m³/s only 10% of the time (over a year period). The flow guaranteed 90% of the time (329 days per year) is estimated at 3.4 m³/s.

Table 6.2 Flow duration curve of the Luegere River at the hydroelectric project

Stream Flow		Exceedance Probability
[M^3/S]	[L.S.KM^2]	[-]
1.41	1.07	Q95%
1.59	1.21	Q90%
1.99	1.51	Q80%
2.57	1.95	Q70%
3.39	2.57	Q60%
4.56	3.46	Q50%
5.99	4.55	Q40%
7.83	5.95	Q30%
10.74	8.15	Q20%
16.29	12.37	Q10%
20.91	15.88	Q5%

Figure 6.5 Modelled flow duration curve of the Luegere River at the hydroelectric project



7.0 PROJECT STATUS AND IMPLEMENTATION PLAN

7.1 Project Status

The project developer has achieved most of the project preparation steps as indicated in Table 7.1.

Table 7.1 Project preparations status

S/no	Activity	Implementation status
1.	Acquisition of land for hydro power development	Done: The official full land title is being processed and shall be availed accordingly.
2.	Water Permit acquisition	Done: Lake Tanganyika basin water board was officially processed and approved for development activities since May 2018.
3.	Environmental and Social Impact Assessment (ESIA)	Done: Approval of the ESIA report by NEMC on progress
4.	Project Feasibility Study - Complete Review	On Progress: The developer has nominated a consultant that will undertake the assignment though the applied PPSF Grant arrangement.
5.	Preparation of project financial model and Bankable business plan	Partially Done: The available project financial model and business plan have been prepared based on the pre-feasibility study report. The documents will be reviewed after feasibility study complete review.
6.	Project Building Permit	Not done: The permit will be applied after successful completion of feasibility study incorporating power plant and civil works design scope which is expected in March or April 2024.
7.	Standardized Power Purchase Agreement (SPPA)	Not done: The Standardized Power Purchase Agreement (SPPA) as guided by the Small Power Project (SPP) rules to be formally applied negotiated and agreed upon by the power off-taker TANESCO and Project Developer during feasibility study process.
8.	Generation and Transmission Licenses by EWURA	Not done: Both provisional power generation and transmission licenses to be applied subject to approval of project feasibility studies and EIA certificate.
9.	TIC Certificate of Incentives	On progress: TIC Certificate of Incentives online Application process converted onto

		successful progress to date. Multiplex Development team has successfully completed set of Application documents submitted TIC for reviews & approval.
10.	Compensation/Resettlement Action Plan	On progress: Locals content Compensation /Resettlement Action Plan is on highly positive and cooperative progress involving all stakeholders and Village & District Council Level.
11.	Social-Economic Impact & Gender Development Promotion	On progress: This is currently being conducted in parallel with the ESIA activities.

7.2 Government/Donor Support and Regulation

Multiplex Systems Limited is developing the project according to regulations and legislation of Tanzania. The following are governing bodies of development and operation of small hydropower projects:- EWURA, NEMC, Ministry of Energy, Ministry of Land and Human Settlement, BRELA, Tanzania Revenue Authority, Uvinza District Council and Lake Tanganyika Water Basin Authority. So far, the company has been granted a letter of commitment by the Rukoma village government (for allocation of 150 acres of land) and a provisional water permit by Lake Tanganyika Basin Water Board. The project may also qualify for grant financing from REA through Tanzania Rural Electrification Expansion Project (TREEP) with funding from the World Bank.

7.3 Implementation plan

Table 7.2 Implementation time frame

Milestone	Key Activities	Deliverables	Responsibility Party	Proposed timeline	Year 1				Year 2				Year 3			
					Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Conducting Feasibility studies and Engineering design	Preparation of technical Engineering report	Technical Engineering report	Technical Engineering Consultant & Multiplex Systems Ltd	6Months												
	Conducting Geological & Geotechnical studies	Geological & Geotechnical reports	Technical Engineering Consultant & Multiplex Systems Ltd													
	Conducting engineering design	Engineering design/drawings	Technical Engineering Consultant & Multiplex Systems Ltd													
	Preparation of BoQ	Project BoQ	Technical Engineering Consultant & Multiplex Systems Ltd													
Updating Project financial model and preparation of Bankable Business plan	Updating project Financial model	Project financial model in editable Excel file	Business Consultant & Multiplex Systems Ltd	3 Months												
	Preparation of Bankable Business plan	Business plan document	Business Consultant & Multiplex Systems Ltd													
Credit facility application	Loan application to cover 70% of total investment cost	Financial close documents	Multiplex Systems Ltd	6 Months												
Tendering and mobilization works	Biding, contracts engagement with selected contractors and mobilization	Signed contract (s) with contractor (s) for project construction works.	Multiplex Systems Ltd and project Financier	3 Months												
Construction and installation works	Construction of weir, river diversion, desilting structure, forebay, penstock, power house, tailrace,33kV transmission line and installation works	Completed project structures and installations	Contractors, Multiplex Systems Ltd and project Financier	18 Months												
Project	Project testing and	Commissioning	Contractors, Multiplex													

Commissioning	commissioning	report	Systems Ltd and project Financier													

8.0 FINANCIAL AND ECONOMIC VIABILITY OF THE PROJECT

8.1 Key Assumptions

The financial plan depends on important assumptions presented in Table 8.1 here below:

Table 8.1: Key Assumptions

Parameters	Value
Project construction period	24 Months
Plant capacity (Max generation per year) kWh	34,400,000
Assumed Energy losses (5%) kWh	1,720,000
Power available for sale per year (kWh)	32,680,000
Plant life	30 years
SPPA tariff during debt service period (US$/kWh)	0.15
SPPA tariff After debt service period (US$/kWh)	0.095
SPPA contract period	20 years
Depreciation rate	4%
Inflation rate	4.5%
Discount rate (cost of capital)	15%
Insurance cover for PP&E	0.5%
Debt equity ratio	70:30
Loan repayment duration	10 years
Loan interest rate	6.5%
Loan appraisal fee	1.28%
Loan grace period	2 years on principal
Income tax rate	30% of EBT

8.2 Investment requirements

The total expected project investment is US$ 21,629,230 (around 54.57 Billion TZS). We propose a 70:30 debt-equity ratio for the project. Multiplex Systems Limited is seeking for a loan from financiers amounting to US$ 15,150,000; Grant of US$ 1,000,000 and US$ 5,479,230 as equity. We suggest this loan to be a 10 years loan with 2 years grace period and an interest rate of 6.5% per year. The loan we seek is a project loan secured by the underlying assets of the project. A breakdown of investment cost and financing structure is as shown in Table 8.2 and 8.3 respectively.

Table 8.2: Investment cost

Cost Category	Mn TZS	US$	% of Costs
Initial Setup Cost			
Land acquisition and other permits	819.98	325,000	1.50
Project feasibility studies, business planning, Engineering design, reviews and aproval	1,009.20	400,000	1.85
Access road	1,639.95	650,000	3.01
Sub-total: A	**3,469.13**	**1,375,000.00**	**6.36**
Generation cost			
Civil works:			
Dam/weir, spillway, purge and intake	2,198.04	871,200	4.03
Abstraction (river diversion)	2,523.00	1,000,000	4.62
Desanding structure	3,784.50	1,500,000	6.94
Forebay and Reject structure	1,261.50	500,000	2.31
Penstock including corrosion protection, delivery and installation	8,325.90	3,300,000	15.26
Power house and Tailrace channel	4,595.90	1,821,600	8.42
Access lanscaping, architectural finishes	1,198.43	475,000	2.20
Canal including service road and stormwater management	996.59	395,000	1.83
Mobilization, installation and demobilization	4,289.10	1,700,000	7.86
Sub-total: B1	**29,172.94**	**11,562,800.00**	**53.46**
Equipment:			
Electromechanical equipment (generator, turbin, transformers, switchgear etc)	9,082.80	3,600,000	16.64
Hydromechanical equipment (gates, screens, craneage, communication including transport etc)	2,523.00	1,000,000	4.62
Sub-total: B2	**11,605.80**	**4,600,000.00**	**21.27**
Transmission cost			
33kV transmission line (5km)	1,021.82	405,000	1.87
System protection	491.99	195,000	0.90
TANESCO interface connection	378.45	150,000	0.69
Sub-total: C	**1,892.25**	**750,000.00**	**3.47**
Contingencies			
Civil works contingencies (10%)	2,917.29	1,156,280	**5.35**
Equipment contingencies (5%)	580.29	230,000	**1.06**
Transmission cost contingencies (10%)	189.23	75,000	**0.35**
Sub-total: D	**3,686.81**	**1,461,280.00**	**6.76**
Working capital			

Dealing with stake holders, technical personnel's requirements, Tendering, Legal, Social and environmental mitigation costs, etc.	1,639.95	650,000	3.01
Transport (vehicle for the project)	239.69	95,000	0.44
Financial appraisal/financial close	379.46	150,400	0.70
Interests during construction	2,484.52	984,750	4.55
Sub-total: E	**4,743.62**	**1,880,150.00**	**8.69**
Grand Total Cost Estimate	**54,570.55**	**21,629,230.00**	**100.00**

Table 8.3: Project Financing Structure

Category	Mn TZS	US$	%
Equity:	**13,824.10**	**5,479,230.00**	**25.3%**
Grants	**2,523.00**	**1,000,000.00**	**4.6%**
Loan	**38,223.45**	**15,150,000.00**	**70.0%**
Total Investment	**54,570.55**	**21,629,230.00**	**100.0%**

8.3 Operating costs

The operating costs are grouped in three sub-categories; fixed costs, variable costs and financing costs. Annual inflation of 4.5 % is assumed in most cost items to include the price rise in the annual costs. The true inflation may be lower than this.

8.3.1. Fixed costs

Fixed costs are to be paid irrespective of operational or financial outcome. For the proposed Luegere hydropower project these include personnel & office costs, insurances, permit fees and depreciation.

8.3.1.1. Personnel & office costs

This cost item covers about 18% of all fixed costs. The staff salary cost is relatively high because running a power plant on 24hrs basis requires 3 shifts. The total annual staff cost is 167,580 USD, including taxes and governments charges.

8.3.1.2. Insurances

Having a covering insurance against the property damages is not a guarantee of compensation, if damage happens. In any case fire hazard and staff injuries by accidents are covered by insurances. Third party insurances are applied if they are compulsory in power business.

8.3.1.3 Permit fees

These are government fees charged related to the operations of the plant, such costs include water permit, land lease fee, business licenses, etc.

8.3.1.4. Depreciation

The depreciation time of machinery, buildings and installations is set at 25 years.

Typically following life time can be used to some tangible assets in a hydropower business:
This cost item is usually not included in fixed cost, but because of its nature it is displayed here for the reason of reminding about its existence.

8.3.2. Variable costs

Variable costs typically change according to the input of resources. For the proposed Luegere hydropower project these costs include maintenances, service by outside providers, travelling, transportation and training costs.

8.3.2.1. Mmaintenances

Hydroelectric installations require constant care. Care of all hydroelectric installations are included in this vote. Typically 4% to 5% of the total property, plant & equipment of the investment value is counted for annual need of maintenance. The amount is kept the same for the four first years as the components are still rather new. Later a 4 % annual increment is added. No major repairs are expected within the first 10 years. Luegere River will carry a lot of soil material during the rainy spell. This material causes clay silt where the water flow is slow or stops. For this reason the weir must be cleaned regularly. The clay is abrasive material and will cause the penstock and turbine runner wheel wear. These are few items in need of constant overhaul.

8.3.2.2. Services by outside providers

All needed services are not self-produced. There are presently companies specializing to services needed by a hydropower company. A good example is the river stream gauging, meteorological services, transportation services, project management consultancy services, etc.

8.3.2.3. Travelling and transportation cost

Travelling in the remote areas in Tanzania is time-consuming and costly. Kigoma Region is among the least developed area in Tanzania, and the Uvinza District the least developed part of the region. During the EPC-phase some very demanding transport operations must be arranged, because of the heavy components. They are once of a kind-events, but a power company has plenty of transportation needs in its normal operations. Medium weight 4 WD vehicle is needed for the maintenance of the power line. Part of the transportation services can be hired.

8.3.2.4. Training

There will be an extensive training program for the staff responsible for operations. The training and inletting will be provided largely by the supplier of the equipments. Need for IT-training and using remote control facility is needed. Staff on job training programs will be carried as required to ensure efficient operation of the plant.

8.3.3. Financing costs

Financing costs should actually belong to fixed costs, but are usually displayed separately.
The total investment capital is 21,629,230USD. The equity part is proposed to be 5,479,230USD; the Grants amount is 1,000,000 USD and the loan part 15,150,000USD. In this context an interest of 6.5 % is paid on the loan balance capital annually. Loan refund is also counted as a financing cost. The loan capital will be refunded after two years grace period. The loan-equity ratio is assumed to be 70:30, but potential investors are given opportunity to propose different arrangement.
A summary of projected operating costs of the project for 10 years after commissioning is presented in Table 8.4.

Table 8.4: Summary of Project Operating Costs

S/No.	Category	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
1	Personnel cost	167,580	167,580	167,580	175,121	175,121	175,121	183,002	183,002	183,002	191,237
2	Stationeries	500	500	500	523	523	523	546	546	546	571
3	Office utilities	900	900	900	941	941	941	983	983	983	1,027
4	Repair and maintenances	45,000	45,000	45,000	47,025	47,025	47,025	49,141	49,141	49,141	51,352
5	Permits fee	4,000	4,000	4,000	4,180	4,180	4,180	4,368	4,368	4,368	4,565
6	Personnel on job training	6,000	6,000	6,000	6,270	6,270	6,270	6,552	6,552	6,552	6,847
8	Insurances	84,564	81,181	77,934	74,817	71,824	68,951	66,193	63,545	61,004	58,563
10	Services by outside providers	20,000	20,000	20,000	20,900	20,900	20,900	21,841	21,841	21,841	22,823
11	Travelling	18,000	18,000	18,000	18,810	18,810	18,810	19,656	19,656	19,656	20,541
13	Other costs	8,000	8,000	8,000	8,360	8,360	8,360	8,736	8,736	8,736	9,129
					-						
	Total	**354,544**	**351,161**	**347,914**	**356,946**	**353,953**	**351,080**	**361,018**	**358,370**	**355,828**	**366,655**

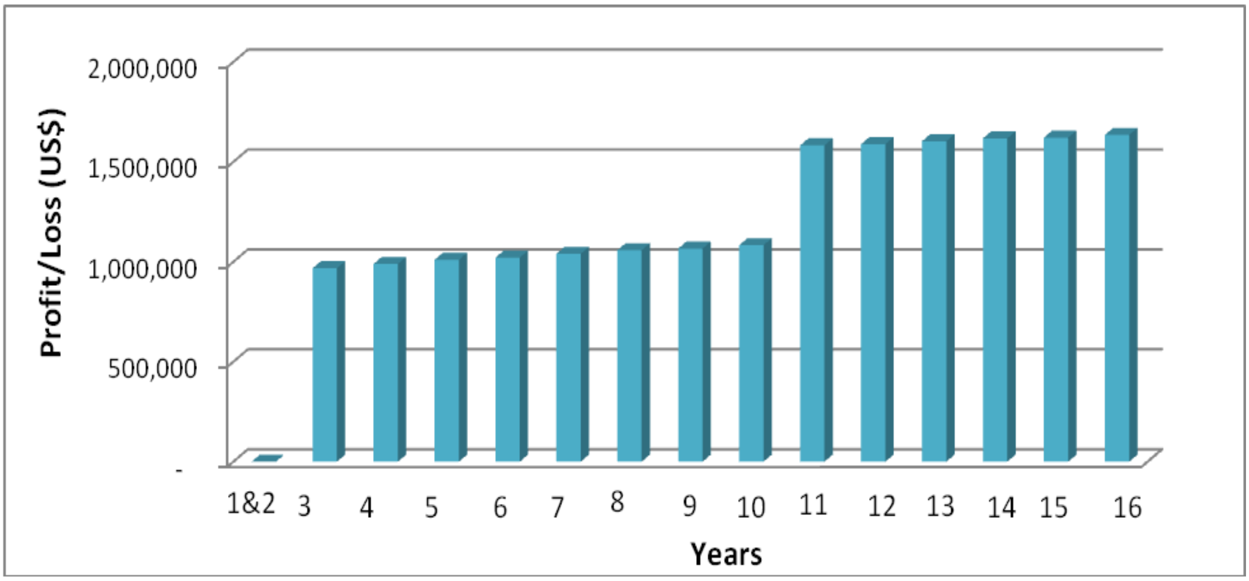
8.4 Expected Project Returns

Based on the information provided and described in all previous chapters, for the rationale of development and implementation of Luegere Hydropower Project, we have projected the Profit or Loss statement, Cash flow and balance sheet of the project for 15 years as presented in annex 1, 2, and 3 respectively. The project financial returns summary is presented in Table 8.5 and Figure 8.1 hereunder.

Table 8.5: Summary of Financial parameters for the first 10 years period

Parameter	Y1 & Y 2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12
Gross income		4,902,000	4,902,000	4,902,000	4,902,000	4,902,000	4,902,000	4,902,000	4,902,000	3,104,600	3,104,600
Operating costs		354,544	351,161	347,914	356,946	353,953	351,080	361,018	358,370	355,828	366,655
EBITDA		4,547,456	4,550,839	4,554,086	4,545,054	4,548,047	4,550,920	4,540,982	4,543,630	2,748,772	2,737,945
EBT		3,870,944	3,901,387	3,930,612	3,946,520	3,973,454	3,999,310	4,011,437	4,035,266	2,260,743	2,269,437
Net result		**185,687**	**190,478**	**195,077**	**189,574**	**193,813**	**197,882**	**191,424**	**195,175**	**609,204**	**601,829**
Net cash flow		**967,924**	**989,234**	**1,009,692**	**1,020,827**	**1,039,681**	**1,057,781**	**1,066,269**	**1,082,950**	**1,582,520**	**1,588,606**
NPV USD	598,146		Detailed information on economic/ financial performance is available in the projected financial statements presented in Annex 1, 2 & 3.								
IRR %	19.6%										
Payback Period	7 Yrs	3 Months									

Figure 8.1: Profit or Loss for 14 years of project operations



8.5. Sensitivity analysis and possible risks

8.5.1 Sensitivity analysis

The sensitivity analysis of the project was done to check the variation on the projected project performance under given circumstances; First, by increasing operating expenses by 10% and Secondly, by decreasing tariff by 10%.

Table 8.6 Sensitivity Analysis

Parameters	**Base Case**	**Scn 1**	**Scn 2**
NPV	598,146.106	516,919.88	233,232.48
Equity IRR	19.6%	19.0%	16.5%
DSCR	> 1	> 1	> 1
Payback period	7 Yrs 3 month	7 Yrs 4 month	7 Yrs 9 month
Note:	Base Case: Chosen scenario		
	Scn 1:Alternative scenario - increase of Opex by 10%		
	Scn 2: Alternative scenario - decrease of tariff by 10%		

First: increasing operating cost by 10%

- The internal rate of return decreased to 19.0% and it is above the cost of capital.
- The Net Present Value decreased to positive value still indicating good return on the investment.
- The payback period increased to 7 years 4months which is reasonable for recovery purposes.
- The Debt Service Cover Ratio for the whole period of loan is greater than 1 indicating that the cash flow outweighs the cost of financing.

Second: Decreasing tariff by 10%

- The internal rate of return decreased to 16.5% which is above the cost of capital.
- The Net Present Value decreased to a positive value indicating good return on the investment.
- The new payback period is 7 years 9 months, and it is reasonable for recovery purposes.
- The Debt Service Cover Ratio for the whole period of loan is greater than 1 indicating that the cash flow outweighs the cost of financing.

Based on the sensitivity analysis, it can be concluded that given worse scenarios on the financial projections, the proposed project is economically feasible with positive NPV at a discounting factor of 15%, IRR greater than the cost of capital, a payback period of not more than 7 years 9months and a Debt Service Cover Ratio of greater than 1. With this analysis and considering the nature of the project, financing the project is therefore highly recommended.

9.0 SECURITY AND RISK MITIGATION

9.1 Security

The requested credit facility is for 10 years finance with 2 years grace period where the loan principal and interest payments will be repaid quarterly in arrears from the proceeds of sales of electricity to TANESCO. The proposed credit security shall include the underlying assets of the project (Mortgage of the project land, debentures over the plant & machinery) and shareholder's personal guarantee required for fulfillment of conditions precedent as per credit offer.

9.2 Possible Risks and Mitigation

Any project has potential risks during various stages of project development and implementation including the operation. The risks for the proposed Luegere hydropower project can be categorized as technical, social, environmental and financial. Table 9.1 below shows some of the risks identified and their possible mitigation measures.

Table 9.1 Potential project risks, their impact and mitigation plan

Risk Elements	Potential Impact	Occurrences Probability	Mitigation Measures
Hydrology risk; Water flow below capacity	Low water will seriously affect power generation	Low	• The minimum discharge has been taken as project design flow means only partial flow has been taken as a design flow to avoid possible impacts. • The plant will also be designed to operate with two units to ensure power availability all the time. • The project alongside other activities needs to include catchment area conservation. • A gauging station has been installed along Luegere River to obtain data on the river

			flow behaviour.
Construction risks	Cost or schedule overruns	Low	Short construction period will reduce the risk. The contractor whom has to be engaged must be highly experienced in the construction of such Hydropower project in Tanzania. The contract payment terms will be based on fixed payment for performance.
Permits availability	Construction won't allowed without legal permits	Low	The developer already started acquiring all needed permits and since the government has been encouraging investment in energy sectors, it will definitely issue the require permits.
Equipment failure	Poor network uptime and so poor electricity sales	Low	The equipment specified in the electrical supply tender must meet international standards and/or based on the tried and tested TANESCO specifications. Installation quality is also expected to be at least the same as TANESCO. Implementation of a suitable planned maintenance system is foreseen.
Grid outage	Loss of sales	Low	More than one turbine is installed. A full set of service and maintenance spares for 2 years operation forms part of the supply contract. Periodic way leaves clearance.
Operational risk	Poor handling and operations	Low	Training of project staff before commissioning and on job training during plant operation

10.0 PROJECT IMPACTS

10.1 Environmental Impacts

The proposed Luegere hydropower Project is mainly designed to be a "run-of-River". The proposed weir overflowing section height of 4.5m will incorporate a regulating gate where by a certain amount of water is released to remain in the stream bed to retain the existing flora and fauna. Care is taken that the river will not be fully diverted even in the dry season. The purpose of the wall is to divert the stream and is not a damming wall.

The diverted water will be returned fully without pollution back to the present stream bed by the concrete lined tail race in-cooperated right below the power house.

The hydroelectric power plant does not involve any pollution in the system. No CO^2 emission involved in running the whole system. Instead the system will minimize the use of kerosene lamps, diesel generators and diesel engines being used at present. Furthermore, the hydro electric power is one of the natural power regarding the green, renewable energy and environmental friendly system.

An Environmental and Social Impact Assessment (ESIA) study of this project was conducted by a registered EIA Expert, and the results showed that the implementation of the project has less negative environmental impacts and the possible mitigation measures were given.

10.2 Social and Economic impacts

Improved access to modern energy services in rural areas for households' consumption, productive enterprises and service delivery facilities is considered to be crucial for the socio-economic development of the area. This project will contribute to the accessibility of reliable energy to the rural areas where the TANESCO grid is extending.

The project is considered to have positive development impacts for both domestic and business activities in the region. For instance, there are several potential business enterprises in the region such as grain milling machines, sunflower oil processing, carpentry workshops, shops, restaurants etc. which at the moment are using energy produced from fossil products which is quite expensive. Availability of power from the intended project will be the redeemer of the communities from that burden.

ANNEXES

1. Projected Profit or Loss Statement
2. Projected Cash Flow
3. Projected Balance sheet
4. Company Registration Certificates
5. Water right/permit
6. Project Land Ownership Certification
7. TANESCO Letter of Intent (LOI)

Annex 1: Projected Profit or Loss Statement

Particulars	Metric	Years										
		1&2	3	4	5	6	7	8	9	10	11	12
Total Revenues	US$		4,902,000	4,902,000	4,902,000	4,902,000	4,902,000	4,902,000	4,902,000	4,902,000	3,104,600	3,104,600
Total Operating Expenses	US$		354,544	351,161	347,914	356,946	353,953	351,080	361,018	358,370	355,828	366,655
EBITDA	US$	-	4,547,456	4,550,839	4,554,086	4,545,054	4,548,047	4,550,920	4,540,982	4,543,630	2,748,772	2,737,945
Depreciation (Book)	US$		676,512	649,452	623,473	598,535	574,593	551,609	529,545	508,363	488,029	468,508
EBIT	US$	-	3,870,944	3,901,387	3,930,612	3,946,520	3,973,454	3,999,310	4,011,437	4,035,266	2,260,743	2,269,437
Financing Expenses	US$		2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	-	-
EBT	US$	-	1,382,749	1,413,192	1,442,417	1,458,325	1,485,259	1,511,115	1,523,242	1,547,071	2,260,743	2,269,437
Tax	US$	-	414,825	423,958	432,725	437,497	445,578	453,335	456,973	464,121	678,223	680,831
Net Profit	US$	**-**	**967,924**	**989,234**	**1,009,692**	**1,020,827**	**1,039,681**	**1,057,781**	**1,066,269**	**1,082,950**	**1,582,520**	**1,588,606**

Annex 2: Projected Cash Flow

Particulars	Y0	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12
Net profit	-	967,924	989,234	1,009,692	1,020,827	1,039,681	1,057,781	1,066,269	1,082,950	1,582,520	1,588,606
Add Interest & amortization		2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	-	-
Add Depreciation		676,512	649,452	623,473	598,535	574,593	551,609	529,545	508,363	488,029	468,508
Sub Inc. in Wc											
Cash from operations	-	4,132,631	4,126,881	4,121,361	4,107,557	4,102,469	4,097,585	4,084,009	4,079,508	2,070,549	2,057,113
Sub Investments	21,629,230										
Net Project Cash flows	**(21,629,230)**	**4,132,631**	**4,126,881**	**4,121,361**	**4,107,557**	**4,102,469**	**4,097,585**	**4,084,009**	**4,079,508**	**2,070,549**	**2,057,113**
Add New Loans	15,150,000										
Sub Loan repayments		2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	2,488,195	2,488,195		
Add Grants	1,000,000										
Equity Cash flows	(5,479,230)	1,644,436	1,638,686	1,633,166	1,619,362	1,614,274	1,609,390	1,595,814	1,591,313	2,070,549	2,057,113

Annex 3: Projected Balance Sheet

Particulars	**Years**									
	Y3	**Y4**	**Y5**	**Y6**	**Y7**	**Y8**	**Y9**	**Y10**	**Y11**	**Y12**
ASSETS										
Non Current Assets										
Property Plant and Equipment	16,912,800	16,236,288	15,586,836	14,963,363	14,364,828	13,790,235	13,238,626	12,655,221	12,189,685	11,680,036
Current Assets										
Inventory		70,909	70,232	69,583	71,389	70,791	70,216	72,204	71,674	71,166
Debtors										
Bank	4,716,430	6,704,782	5,881,908	4,934,087	3,841,478	2,627,518	1,271,427	19,488	189,872	301,123
TOTAL ASSETS	**21,629,230**	**23,011,979**	**21,538,977**	**19,967,033**	**18,277,696**	**16,488,544**	**14,580,269**	**12,746,912**	**12,451,232**	**12,052,324**
EQUITY AND LIABILITIES										
EQUITY										
Owners Equity	5,479,230	5,479,230	5,479,230	5,479,230	5,479,230	5,479,230	5,479,230	5,479,230	5,479,230	5,479,230
Grants	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Retained Earnings	-	967,924	989,234	1,009,692	1,020,827	1,039,681	1,057,781	1,066,269	1,082,950	1,582,520
CURRENT LIABILITIES										
Creditors								214,367	2,088,597	3,312,351
Tax payable	-	414,825	423,958	432,725	437,497	445,578	453,335	456,973	464,121	678,223
LONG TERM LIABILITIES										
Bank loan	15,150,000	15,150,000	13,646,555	12,045,386	10,340,141	8,524,055	6,589,924	4,530,074	2,336,333	-
TOTAL EQUITY AND LIABILITIES	**21,629,230**	**23,011,979**	**21,538,977**	**19,967,033**	**18,277,696**	**16,488,544**	**14,580,269**	**12,746,912**	**12,451,232**	**12,052,324**

Annex 4: Company Registration Certificate

Annex 5: Water Permit

Annex 6: Project Land Ownership Certification

Annex 7: TANESCO Letter of Intent (LOI)