

Ngonye Falls Hydroelectric Project

Western Power Company

November 2019



180 MW of
new renewable
electricity
generation for
Zambia by
2024

The Ngonye Falls project will see the design and construction of a run-of-river hydroelectric power station on the Zambezi River in the Western Province of Zambia.

The power station will have 180 MW of electricity generation capacity – adding around 8% to Zambia’s total – and produce 830 GWh per year of cost effective, clean, renewable energy for local demand and export. Enough electricity for 200,000 Zambian households or the entire population of the Western Province.

The cost to build the power station will be more than 500 million US dollars, the largest ever private investment in Western Zambia.

The project will have a very low environmental impact and has been designed to be a net positive impact for the local host community.

Construction is due to start in 2021 and last for 3 years. The first electricity production will be as early as 2024.

On the Zambezi river in the Western Province of Zambia

110 km north of Sesheke – major 220/66kV substation and bridge for access to Namibia

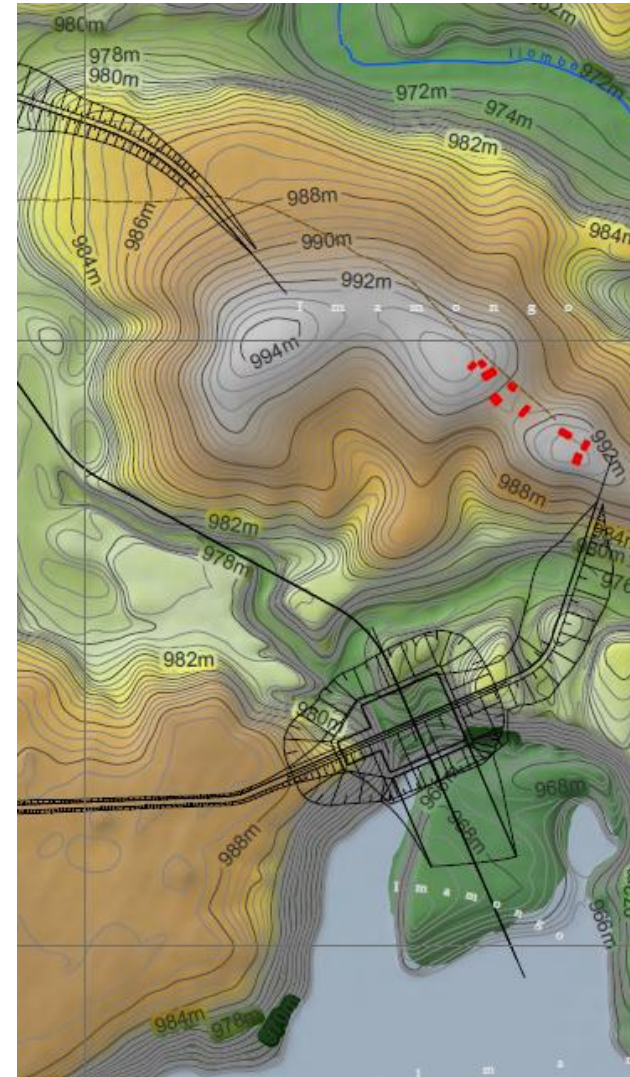
250km from Livingstone / Victoria Falls for access to Zimbabwe and local amenities

2 hours by air from Lusaka to the airstrip 5km from the project site



Ideally located
to improve
electricity
supply and
support
economic
development
in western
Zambia

- An early contribution to help solve Zambia's electricity crisis
- Generating energy for economic development and growth in Western Province
- Strengthening and stabilising the western Zambian power network to reduce losses and outages
- Ideally placed to export power to the Southern African region through existing international connections
- Demonstration of the private sector's ability to work with government to deliver new power infrastructure in Zambia



The upper Zambezi river and Barotse Floodplain

- The Ngonye Falls mark the southern extent of the vast Barotse Floodplains on the upper Zambezi River.
- The floodplains dominate the hydrology of the Zambezi river by storing rainfall from the upper catchment and slowly releasing it into the lower river.
- The floodplains also dominate the lives of the Lozi people who live on them and along their edge.

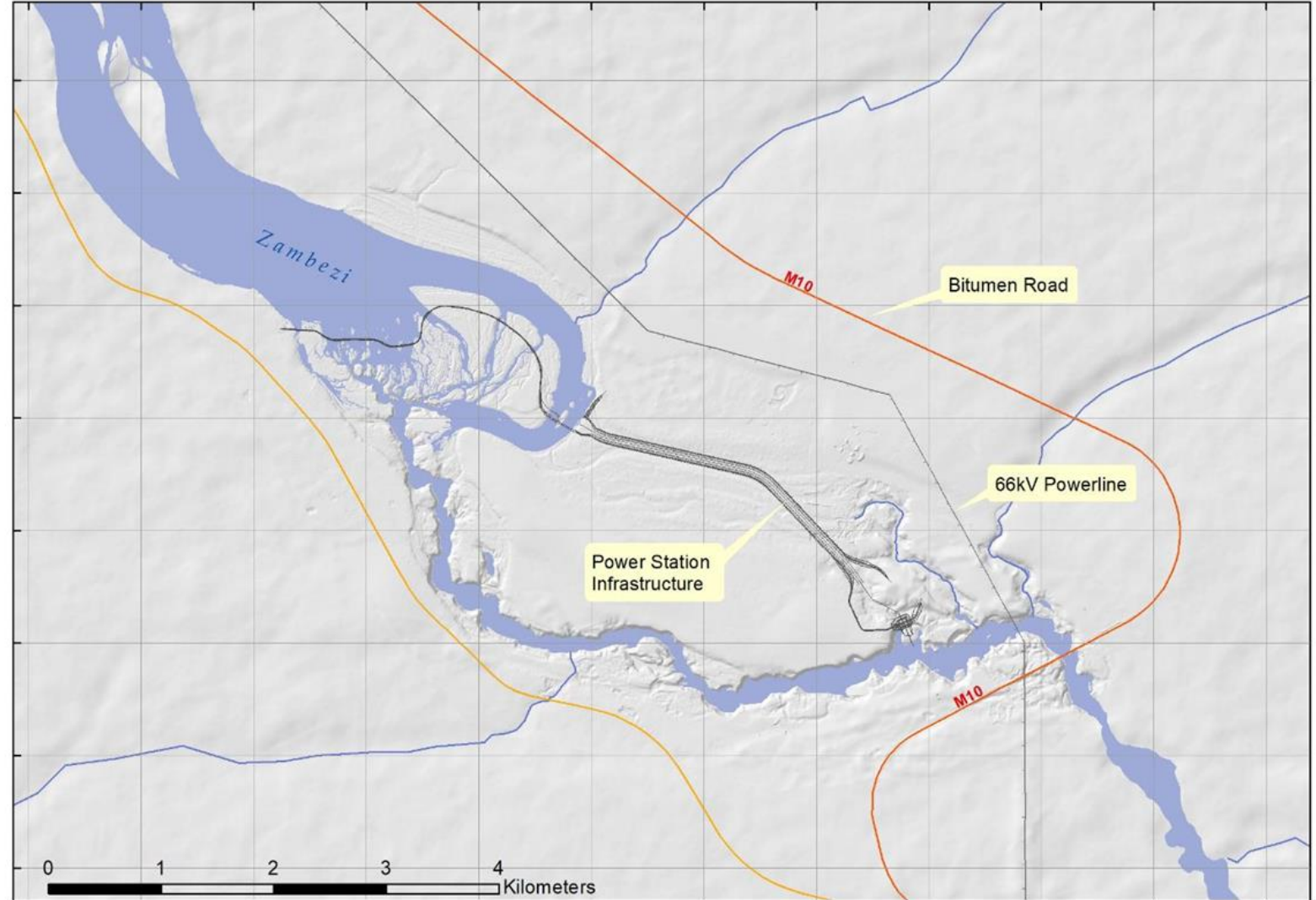


Ngonye Falls

At Ngonye Falls the Zambezi splits into a number of channels and drops over a series of falls and rapids across more than 1km of the river's width.

Below the falls the river flows in a deep, narrow gorge cut into sandstones.

Electricity will be generated by diverting some of the river flow into a 3km long canal to a powerhouse in the gorge downstream where turbines will be spun by the water and in turn driver generator units.



Project Design

A run-of-river design with no high dam, no significant impoundment of water and no lake.

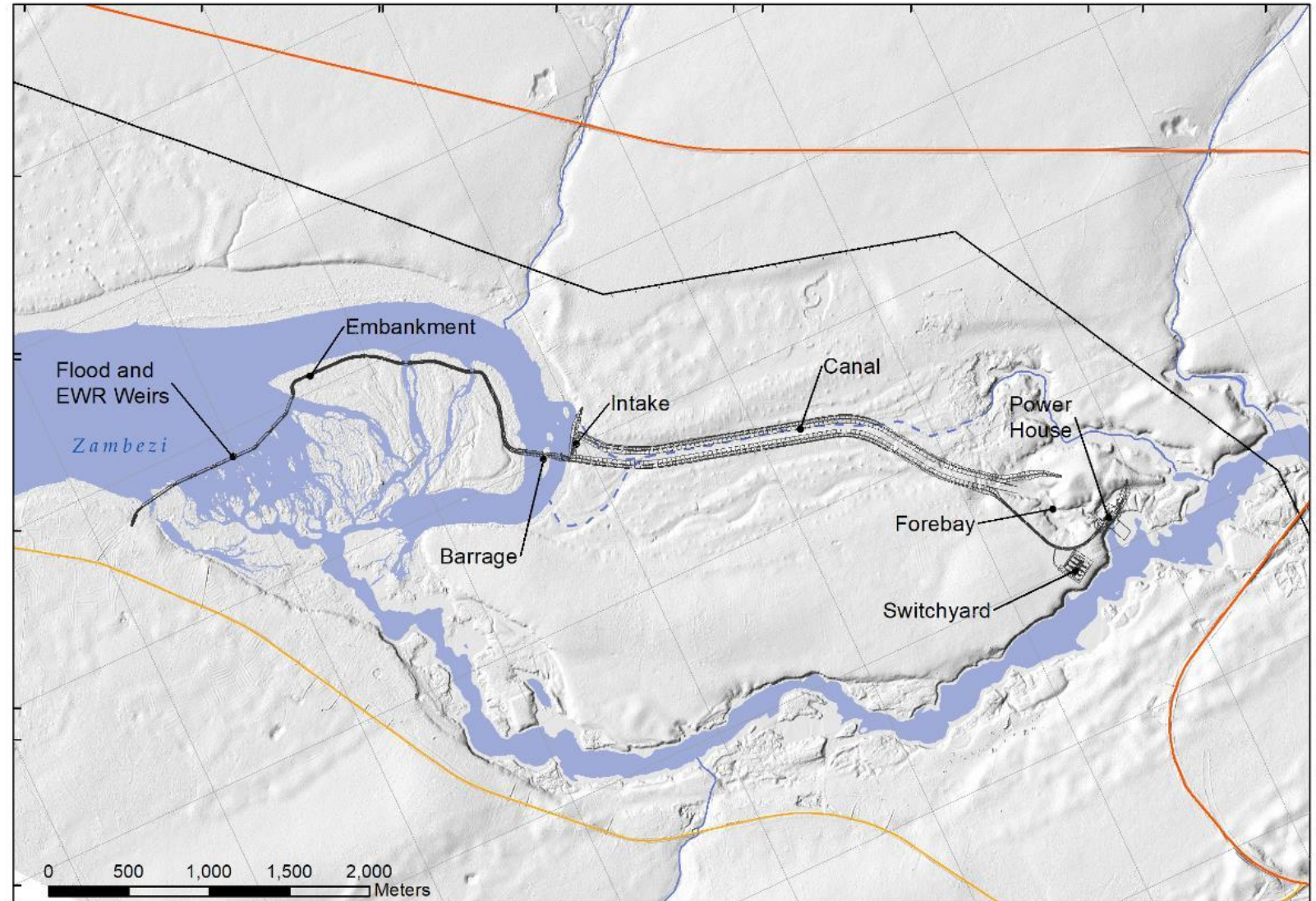
Run-of-river design means significantly reduced environmental and social impact:

- Very low resettlement requirement

- No additional greenhouse gas emissions from a reservoir

- No impact on the flow of the river downstream of the project

But no reservoir means no storage of water and output depends on flow in the river.

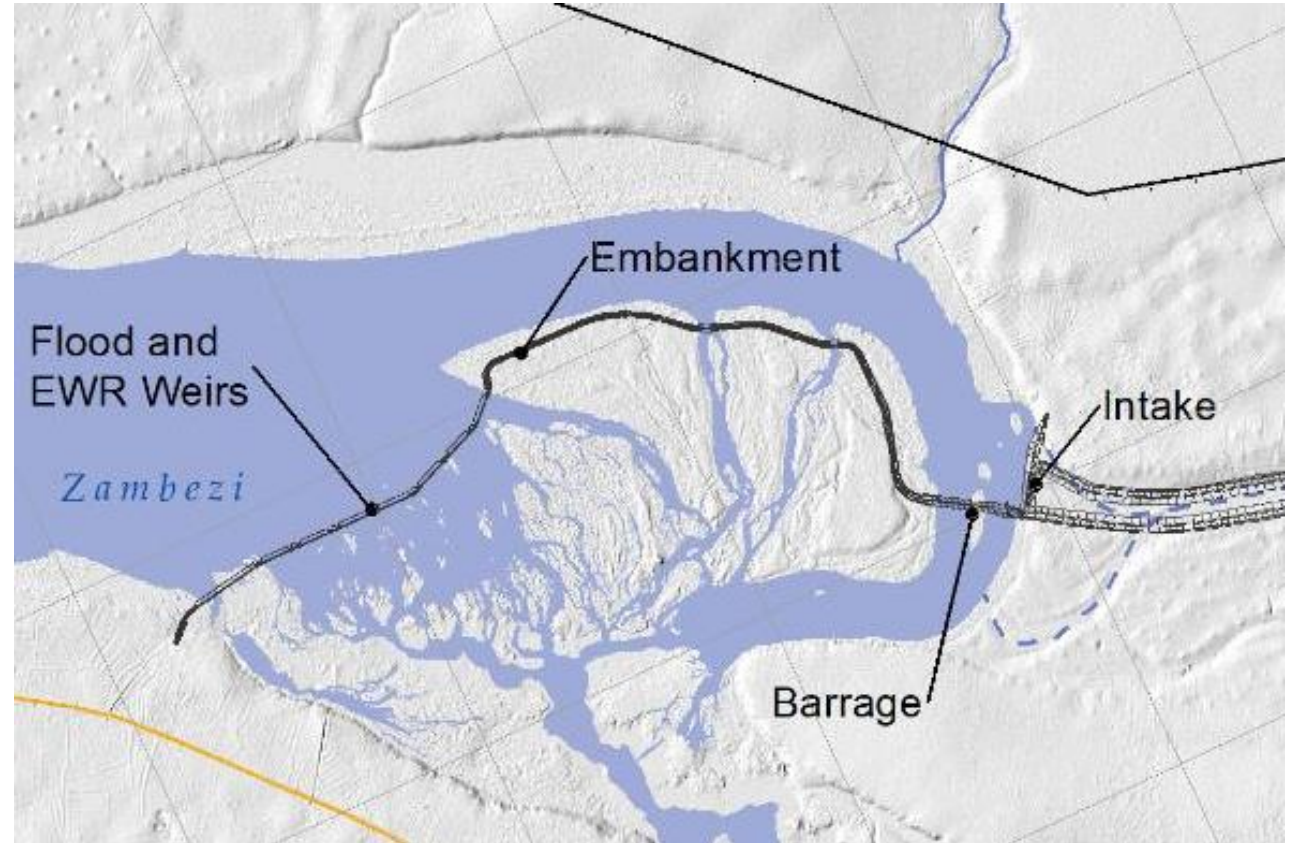


Headworks

The headworks are a series of weirs and embankments and a concrete barrage which are designed to:

- Hold the level of water upstream of the power station at a constant level of 99om above sea level.
- Contain adjustable crest-level weirs that can be dropped to allow flood flows to pass (without causing significant flooding upstream)
- Contain weirs to constantly pass the required Environmental Flow Requirements to maintain the ecology and habitat between the weir and powerhouse.
- Contain fish passages to allow fish to pass up and downstream past the power station

The headworks divert a portion of river's total flow through the intake structure and into the power canal.



Headworks

The headworks across the west (right) river channel include sections of adjustable Environmental Flow Requirement (EFR) weirs which allow constant flow of water and a number of fish ladders, structures to allow fish to migrate past the power station infrastructure.

The adjustable weirs can be raised and lowered to allow more or less water to flow past the headworks.

The access road allows for maintenance of the adjustable weirs.



Canal and Forebay

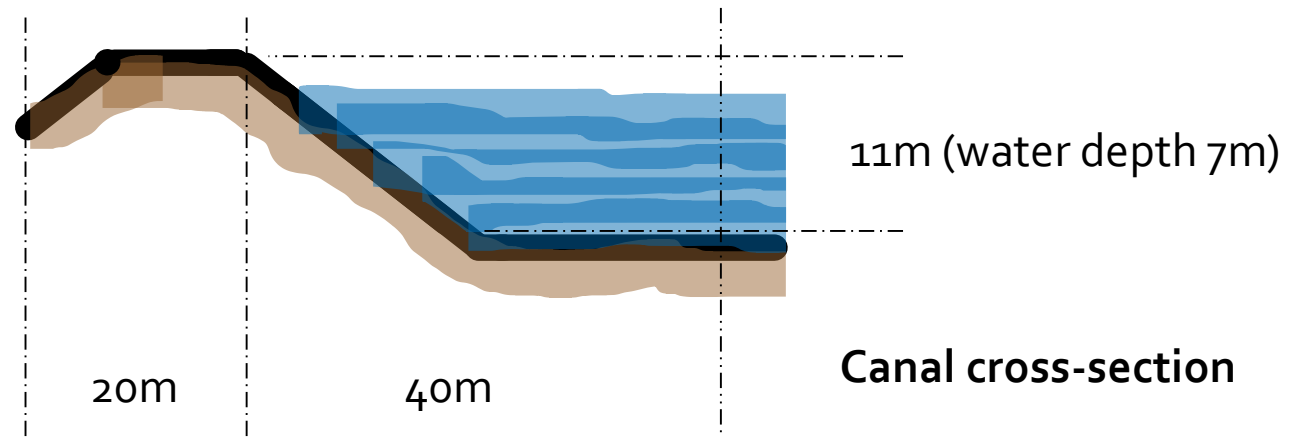
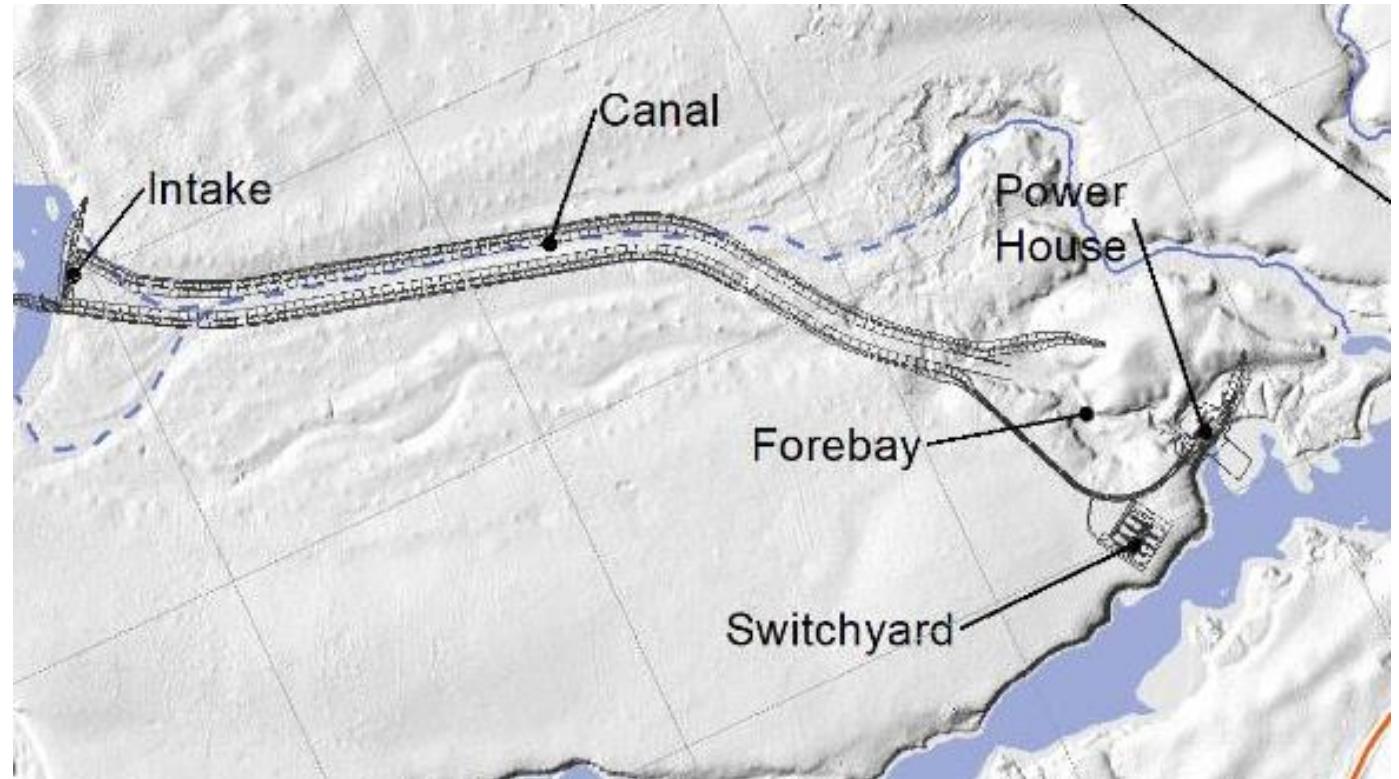
The power canal carries water 3km from the headworks and intake to the powerhouse where the electricity is generated.

The power canal is 11m deep with a maximum water depth of 7m when filled to its capacity of 1,100 cubic meters per second of water flow.

The width of the canal including its retaining embankments and access roads is around 120m.

The canal is partially excavated into the terrain and lined with concrete.

At the end of the canal a forebay is formed from the natural landscape and retaining dams. The forebay holds a buffer of water for the power station to maintain constant flow through the turbines.



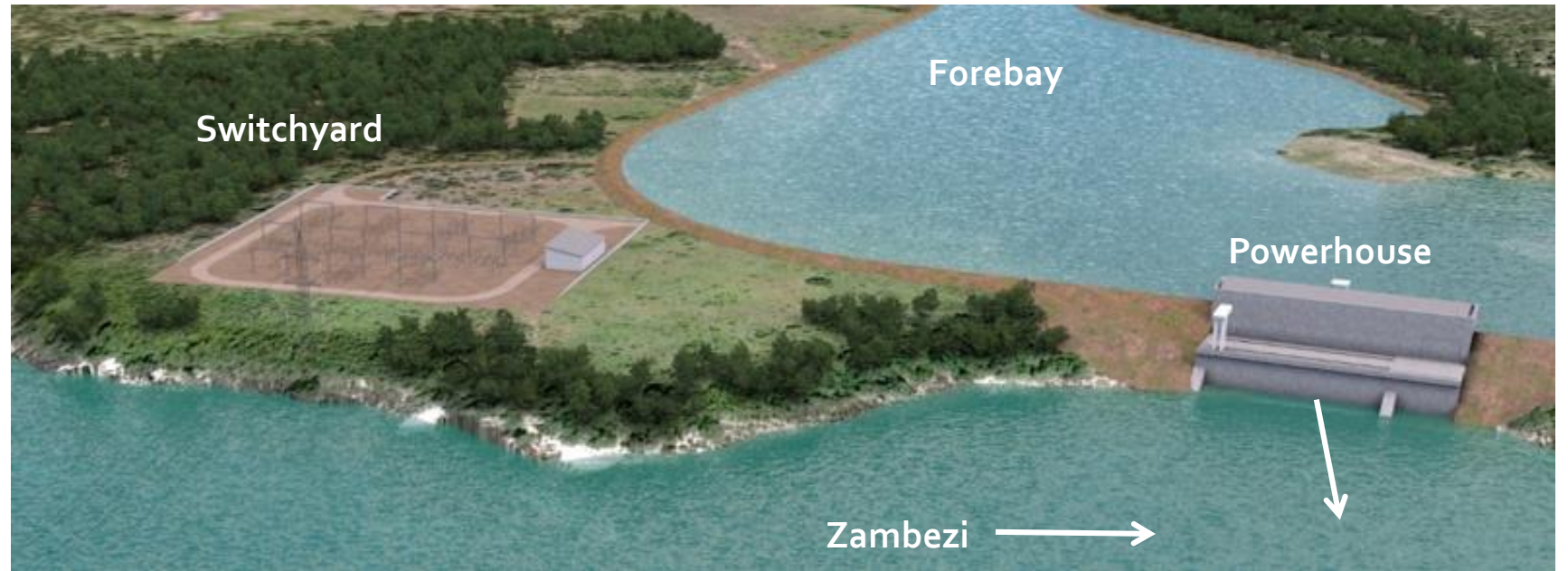
Powerhouse & Switchyard

The powerhouse contains the 4 identical 4.5MW bulb turbines and their generators which spin due to the action of the water and generate the electricity.

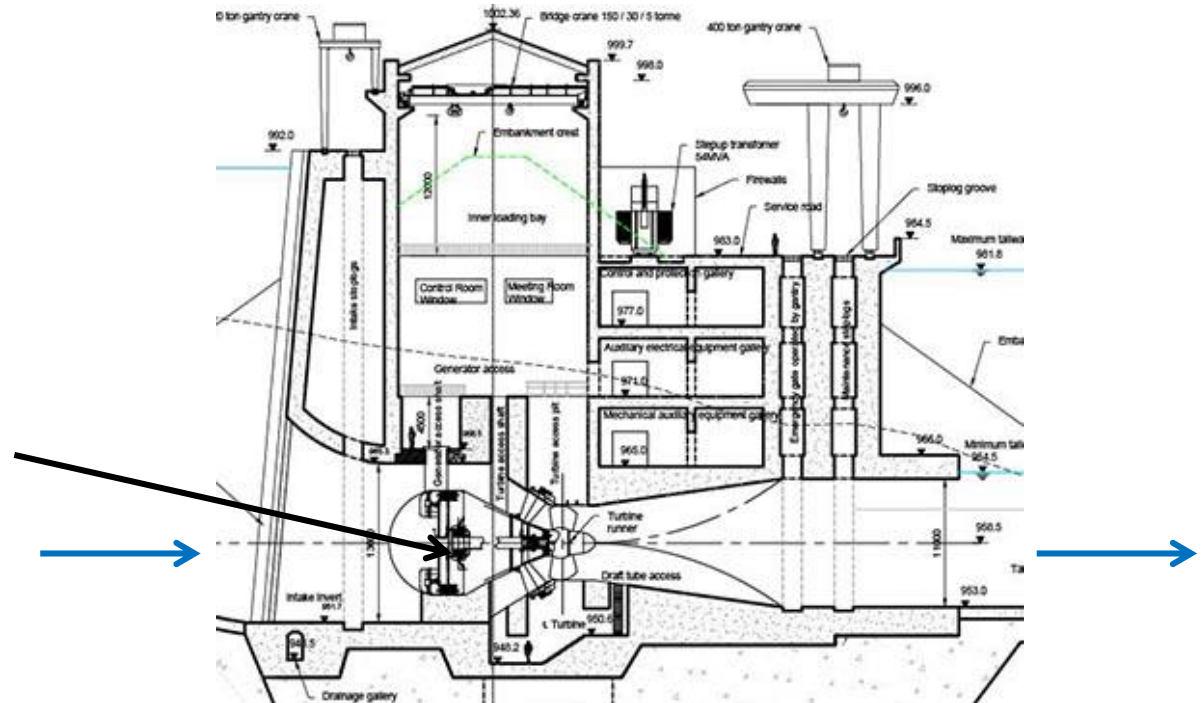
The powerhouse also holds the maintenance and control equipment needed to operate the power station.

The electricity generated is fed to the switchyard where the voltage is raised to transmission level (220kV) and the connection to the national transmission network is made.

The powerhouse is nearly 60m high but the majority of the structure is excavated into the river bank and so is not visible from the surface.



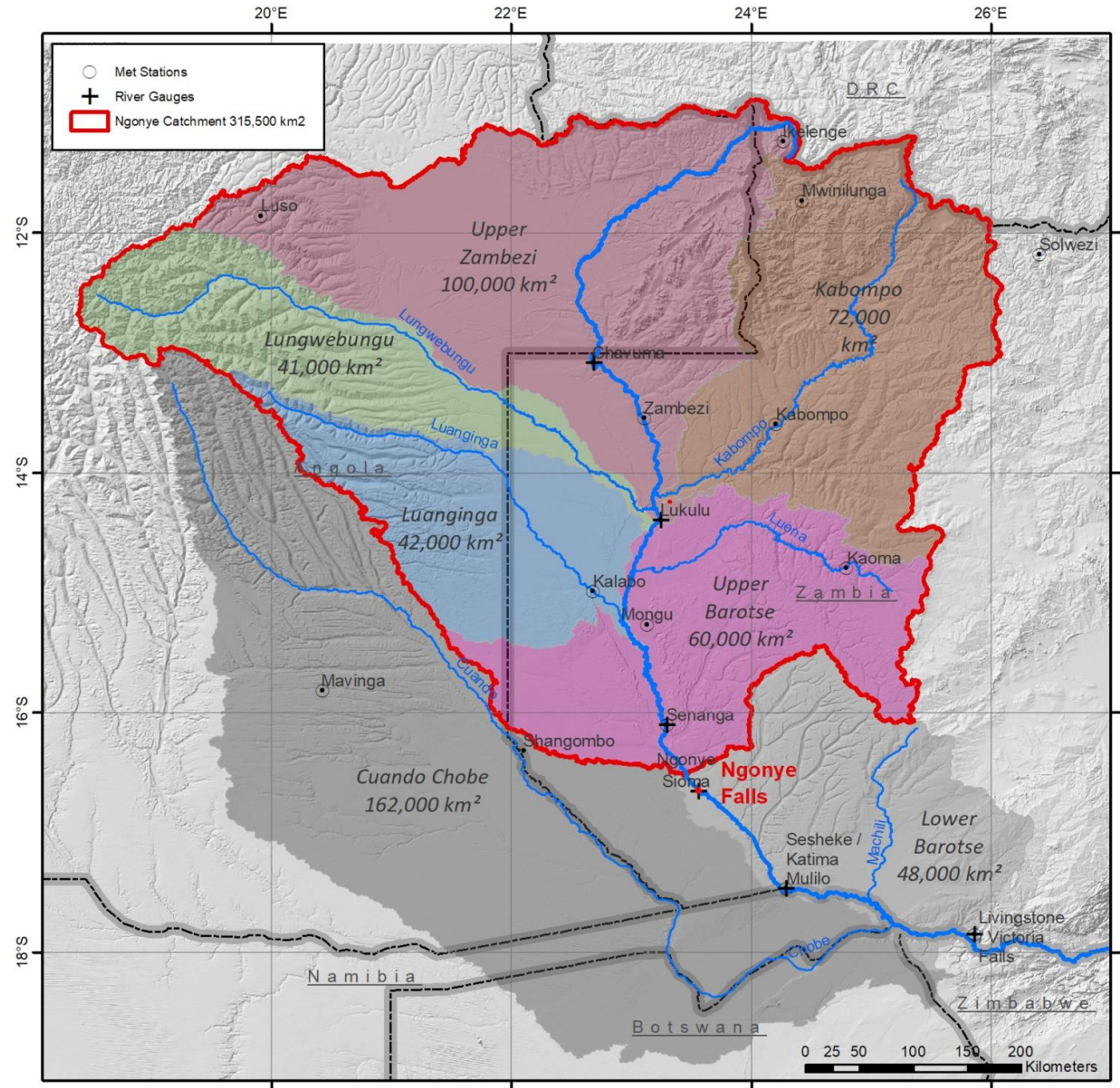
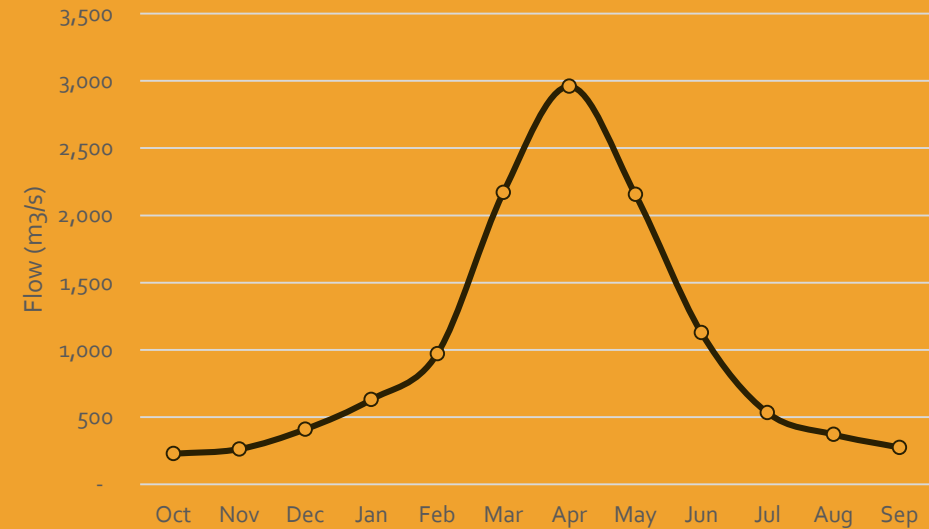
Bulb Turbine and Generator



Zambezi River

The Zambezi river catchment upstream of Ngonye Falls is over 315,000 km² in extent. Because of the large size of the catchment and the buffering effect of the Barotse floodplains the flow at Ngonye changes only gradually through the year.

Because of the seasonal pattern of rainfall in the catchment, the flow at Ngonye is also highly seasonal.



Environmental Flows & Power Generation Flows

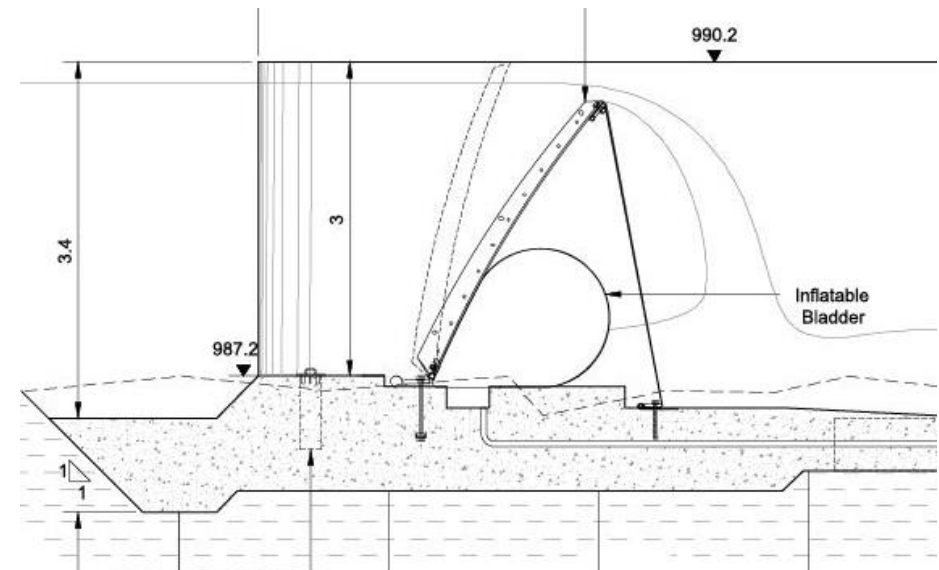
The electricity produced by a hydroelectric power station at any time depends on the amount of water flowing through the turbines and the difference in height (head) between the water at the intake and the at the tailrace or turbine outlet.

As the Ngonye project is run-of-river and does not have a high dam and a storage reservoir then the flow available for power generation depends only on the overall flow in the river and the environmental flow requirements (EFRs).

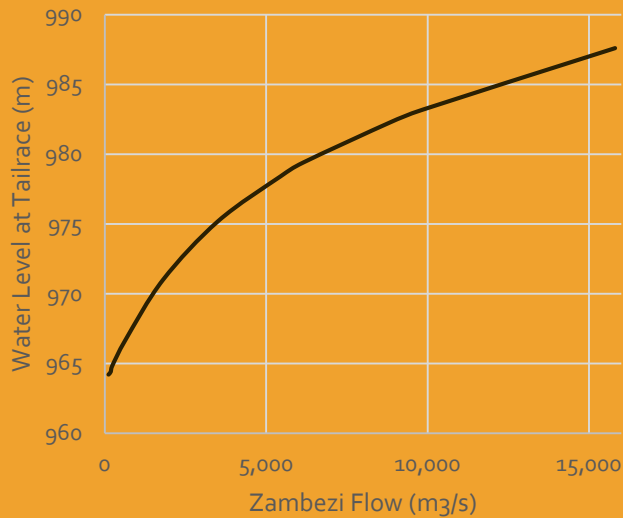
The EFRs are the flows which must be constantly allowed past the weirs and barrage through the natural channels to maintain the aquatic environment.

The EFRs for the project have been calculated through a comprehensive and systematic analysis of a suite of environmental indicator species by an independent consultant. The EFRs depend on the time of the year and also the overall river flow.

The EFRs are set during operation of the power station by raising or lowering the EFR weirs.



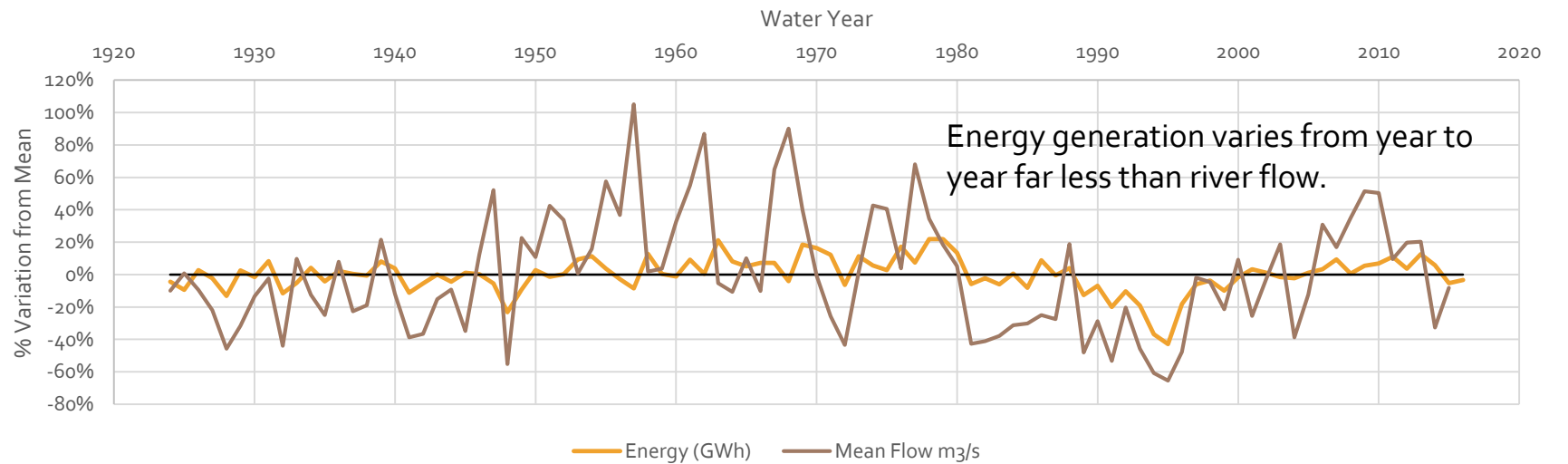
River Level and Generation Head



An unusual feature of the Ngonye Falls project is the variation in generation head through the year caused by water levels in the narrow downstream gorge varying depending on the flow in the river.

During flood flows the downstream gorge floods with water, the water level at the turbines rises and the head available for generation falls.

Because the head increases during draught conditions, when there is less flow, the power station generates more electricity than would be expected during drought years.



Generation Power and Energy

P50 Median Gross Annual Generation	837 GWh
P50 Median Net Annual Generation	807 GWh
Capacity Factor	49%

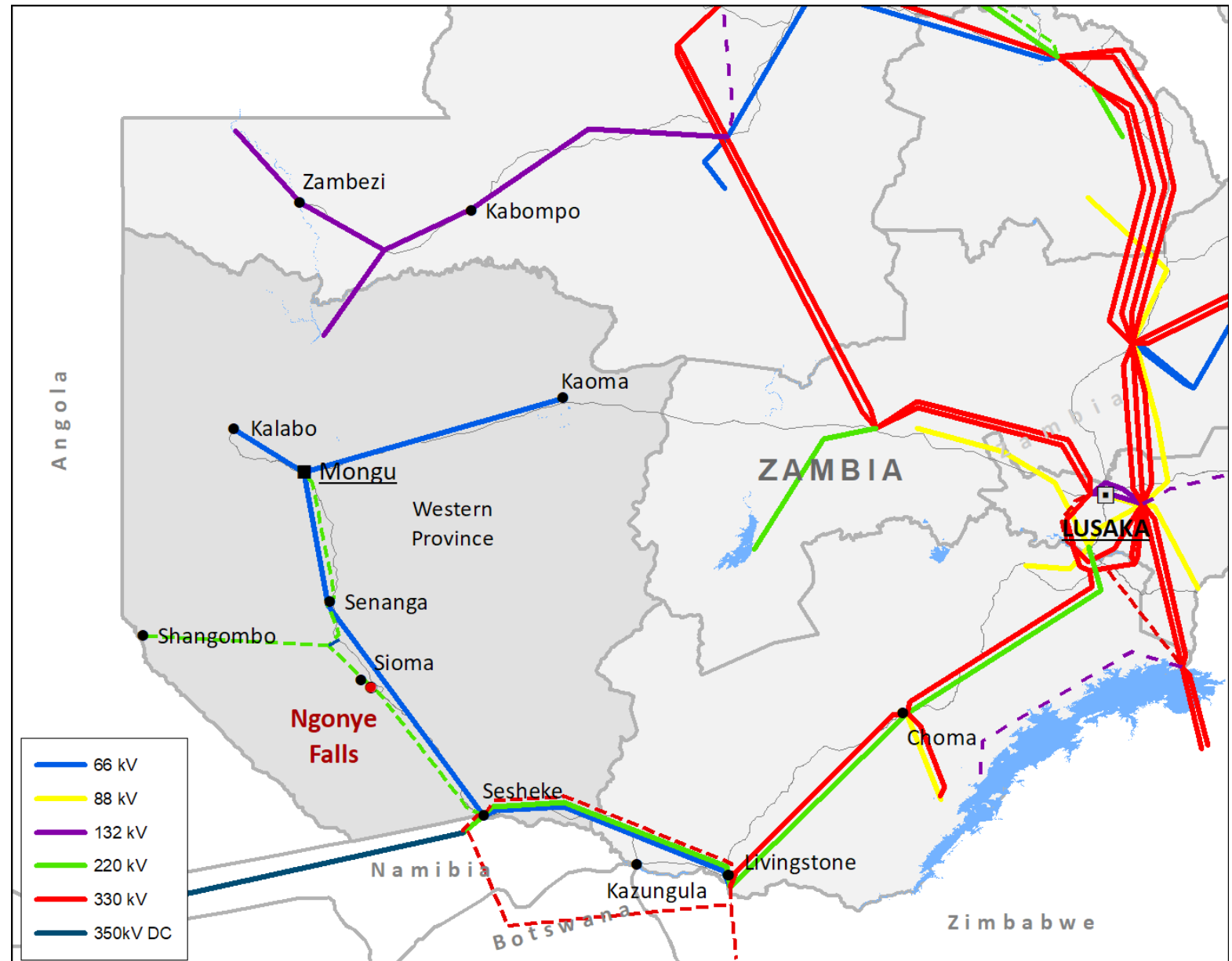
Zambia domestic connections 2017	894,545	houses
Zambia domestic consumption 2017	4,147	GWh
Zambia average household electricity consumption	4,636	kWh / house / year
Zambia average household electricity consumption	386	kWh / house / month
Ngonye Project average annual output	807	GWh / year
Ngonye Project - number of households supplied	174,081	houses
Zambia average number of people per household	5.1	people / household
Ngonye Project - number of people supplied	887,815	people

Power Evacuation

An existing 66kV powerline, which supplies all the electricity for the Western Province, passes within a few km of the project site.

To evacuate all the power produced however, a 220kV powerline will be required to be constructed 110km south to the substation at Sesheke.

ZESCO have committed to the construction of the 220kV transmission line but WPC may take up this project if needed.



Environmental & Social Impact Assessment

A comprehensive Environmental and Social Impact Assessment has been completed to ensure the highest standards of environmental and social compliance.

Conducted according to:

- Zambian national environmental law and regulation - as required by the Zambia Environmental Management Agency (ZEMA)
- International Finance Corporation (IFC) Performance Standards – to enable financing by international finance institutions



NGONYE FALLS HYDROELECTRIC PROJECT

Environmental and Social Impact Assessment (ESIA)

VOLUME I: NON-TECHNICAL SUMMARY

May 2019

DH ENGINEERING
CONSULTANTS

Western Power

Environmental & Social Impact Assessment Components Completed

- Environmental & Social Impact Statement
 - **Biodiversity** including terrestrial and aquatic ecology
 - **Social Impact**
 - **Heritage and Tourism Impact**
 - **Health Impact**
 - **Landscape & Visual Impact**
 - **Environmental Flow Requirements (EFRs)**
 - **Climate Change Impact Assessment & GHGs**
 - **Stakeholder Engagement Plan**
- Resettlement Policy Framework
- Environmental and Social Management and Monitoring Plan

Community Participation and Benefits

- The communities of the Western Province will hold 6% of the equity of the project in recognition of the value of the land and water resources they are providing.
- The project will also pay a fixed community development payment of 500,000 US dollars each year once the power station is operational.
- The funds will be administered by two trusts, one for projects across the Province and one for the area that hosts the project.
- The trusts are being established to have the highest standards of governance and transparency.
- The community led projects that may be supported by the trusts include:
 - Education
 - Water and Sanitation
 - Healthcare

EPC Contractor & Construction



Construction of the power station will be undertaken by specialist EPC Contractor (engineering, procurement and construction) procured through an open, competitive tender.

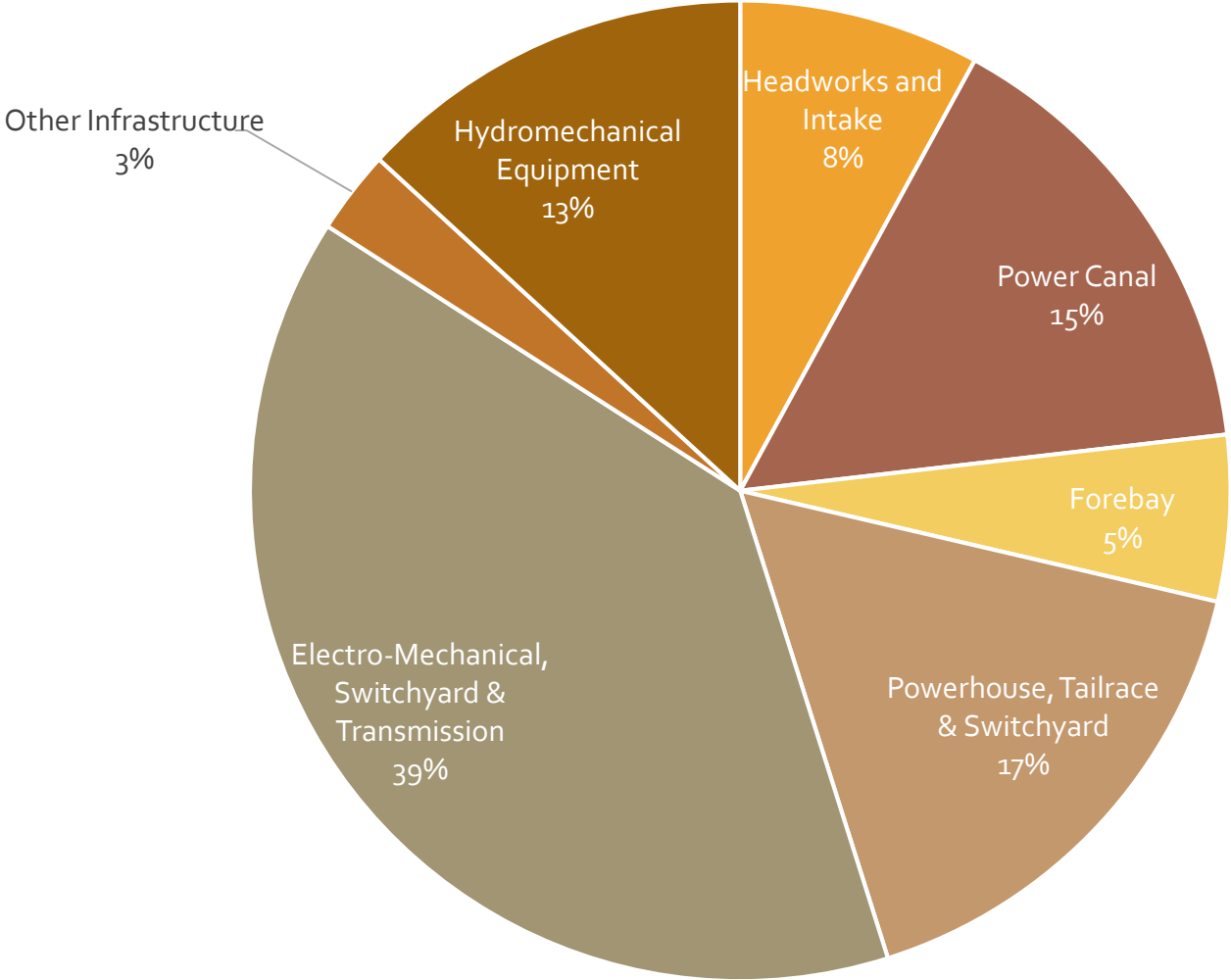


The EPC contractor is being selected based on their experience and expertise in similar projects, the construction and management capacity they can provide and their financial strength. The contractors being considered are all large multinational construction companies.



The construction is expected to last for around 3 years and at its peak will employ up to 3,000 people on site.

Construction Cost Breakdown



Project Finance and Sales

- Western Power will employ a Project Finance type structure to raise the money required to construct the project.
- Project Finance is commonly used to finance large infrastructure projects. It uses the security of a long-term contract – in this case a contract to sell electricity for 25 years – as security to borrow up to 80% of the project cost from a group of lenders.
- For the Ngonye Falls project the lenders will likely include Development Finance Institutions (DFIs) which are organisations funded by governments and mandated to support infrastructure projects in the developing world.
- Western Power is discussing the terms of a Power Purchase Agreement (PPA) with ZESCO, the Zambian national utility for the purchase of all the electricity produced by the power station for a period of 25 years.

Remaining Project Development Milestones



Approval of the Environmental and Social Impact Assessment by the Zambian environmental regulator, ZEMA



Completion and approval of the Resettlement Action Plan



Selection of a major international EPC Contractor for construction of the project by completion of the competitive tender



Completion of the financing for the project including selection of the debt (70%) and equity (30%) financiers



Agreement of the Power Purchase Agreement (PPA) for the sale of all the electricity to ZESCO, the Zambian power utility

Project
Advisors



WHITE & CASE



FIELDSTONE

CHIBESAKUNDA&CO.



Host Community Partners

The Barotse Royal Establishment (BRE) is the administration of the Kingdom of Barotseland headed by His Majesty the Litunga who is the traditional leader of the communities of western Zambia.

The BRE represents all the communities that host the Ngonye Falls Project and own 6% of the project in trust for the community in recognition of the natural resources being supplied to the development.

The BRE have been instrumental in working with Western Power, the Government of Zambia and our other partners to bring the project to a successful conclusion having recognised the development benefits that the project will provide to the people of western Zambia.



Development and Funding Partners



African Power Projects (APP) is a Mauritian project development company established to develop renewable power projects across Southern Africa. APP was set up by a group of private international investors and Zambians. APP has raised significant development funding for the Ngonye Falls project and is an active part of the Ngonye Falls management team in cooperation with InfraCo Africa.



InfraCo Africa is an infrastructure development facility of the Private Infrastructure Development Group (PIDG). InfraCo Africa seeks to alleviate poverty by mobilising private sector expertise and finance to develop infrastructure projects in sub-Saharan Africa's poorer countries. InfraCo Africa receives funding through PIDG's publicly funded trust, from the governments of the UK (DFID), the Netherlands (DGIS) and Switzerland (SECO). InfraCo Africa is a major shareholder in Western Power and is supporting the company with significant development funding as well as expertise in the form of experienced infrastructure development professionals working for the project in Zambia and internationally.



The Development Bank of Southern Africa (DBSA) is a development finance institution that seeks to advance the development impact in Southern Africa by expanding access to development finance and effectively integrating and implementing sustainable development solutions. DBSA seeks to improve quality of life, support economic growth, support regional integration and promote sustainable use of scarce resource. DBSA has supported Western Power from the earliest stages of the project through their Project Preparation Fund which has provided funding for key project studies from inception through to bankable feasibility. Through their involvement DBSA has facilitated significant additional private and public investment in the project.

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