Agatobwe 405 kW Small Hydropower Project

Project Background

The existing Agatobwe hydropower station was erected between 2006 and 2009 and funded by the United Nations. The power station supplies a 6.6 kV mini-grid connected to two small villages producing electricity in accordance with the consumption of the households connected to the hydropower plant.

Current Powerhouse with single Francis Turbine

At present, the plant's output produced in accordance with consumption demand is 15 – 25 kW. However, the maximum turbine capacity and the generator power output of 190 kW cannot be achieved because the system has not been connected to the public power grid of EWSA, and *hence it is and was never possible to test the power station under full load.* The turbine is exclusively controlled manually in accordance with the power demand of the stand-alone grid due to faulty control elements.

The project developer TIGER Ltd conducted a review to improve the output of the plant once the plant is connected to the public grid. MWIP studied the review and agreed with the developer to develop and implement the project.

A site visit was conducted in September 2017, attended by Bjarte Skår from Brødrene Dahl and Thor Mikkelborg from MWIP together with Theo Uwayo from TIGER Ltd, the project owner, to comprehend the scope of works.

In addition, TIGER Ltd appointed a consultant from RMD Consult to review the site and report on his findings. The report is of a high quality and provides valuable insights to the project.

MWIP has reviewed the report, optimized the plant and designed the plant together with Brødrene Dahl and Rainpower, their Norwegian Partners.

Project Location

The project is located on the Agatobwe River, in the Nyaruguru district of Rwanda, near the Burundi Border.

Project Component	Co-ordinates
Intake	02° 45' 35.04'' S 29° 40' 16.44'' E
Powerhouse	02° 45' 50.16'' S 29° 40' 12.42'' E

Existing Hydropower Plant Data

The available system has been designed for a maximum output of 190 kW and is characterized by the data specified below:

Main Components	Unit	Value
Gross Head	m	30
Net Head	m	24
Design Discharge	m^3/s	1,15
Turbine Capacity	kW	~210
Generator Rated Power	kW	~190

Existing Plant Components

The plant is a run of river system with the following components:

- Weir system including reject and outlet to headrace canal
- Headwater canal 525 m in length
- Fine screen and penstock intake
- 50 m steel penstock
- Single Francis Turbine Powerhouse

Geodetic Survey

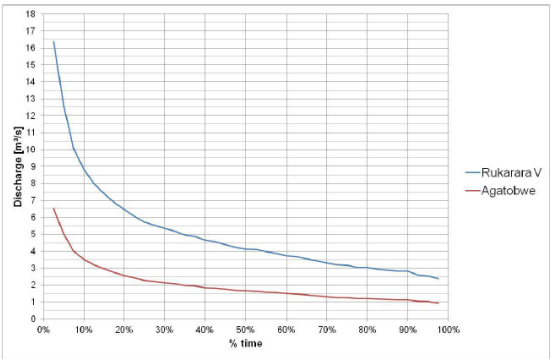
A geodetic survey was conducted of the existing infrastructure indicating the important design elevations for all the components of the plant from the powerhouse to the intake. The survey

allows the engineers to model the current works and gain insight into hydraulic operation of the plant.

Hydrology

Rwanda experiences two rain seasons annually during March-May and August-November. No hydrological gauging stations are located within the catchment of the project area. However, a hydrological study was done in 2014 for the Rukarara V plant located 40 km from the Agatobwe plant.

The catchment area of the project is 143 km^2 and the scaled flow duration curve from the Ruakara V plant flow data indicates a flow rate of 1 m^3/s will be available 95 % of the time. A flow rate of 1.8 m^3/s will be available 40 % of the time.



Flow duration curve

However, the flow duration curve is an estimate and flow measurement equipment will be installed as part of the implementation of the project to measure flow.

Geology

During the site visit no geological risks were identified by the geologist. It is envisaged that there will be no major problem during the excavation of the powerhouse.

Refurbishment Design

Connecting to the grid

The first step will be to connect the 6 kV mini-grid to the 30 kV public grid using one transformer. The next step is to connect the refurbished plant to 30 kV public grid using another transformer.

A new transmission line has been constructed and runs adjacent to the existing powerhouse, shown in the right of the photo below. As a result, the connection point will be positioned next to the powerhouse to allow connection to the public grid.

Newly constructed transmission line

The balance of plant will be installed inside existing building. The high voltage equipment and kiosk will be installed outside of the powerhouse.

The balance of plant contains the following:

- Switch gear
- Control of plant done by PLC
- HMI panel for operation
- Protection relay generator
- DC supply with battery backup

Electro-mechanical Equipment

Upon investigation and requirements stipulated in the Power Purchase Agreement it was decided to replace all the electro-mechanical equipment with higher efficiency equipment and world leading technology to maximize the output of the plant.

Horizontal Francis Turbine

The horizontal Francis turbine will be replaced with a larger horizontal Francis turbine. The table below shows the main data of the new turbine.

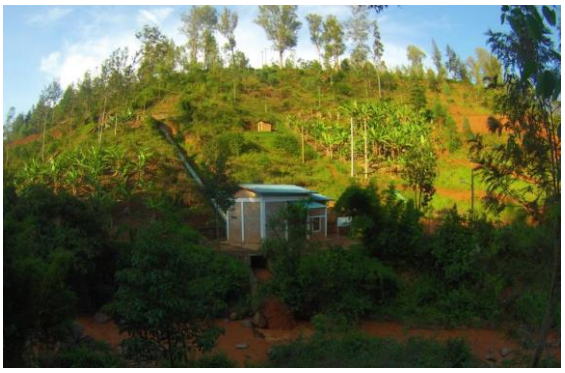
Main Data	Unit	Values
Power Rating	kW	405
Speed Rating	rpm	600
Design Head	m	24
Rated Flow	m^3/s	1.9

Increase infrastructure capacity

To abstract a total of 1.9 m^3/s, the headworks and conveyance capacity must be increased.

A simple solution has been designed which includes two additional DN 600 mm GRP pipe from the intake to the forebay, buried alongside the canal with minimal disturbance to existing infrastructure, migrating construction risks.

In addition, a portion of the penstock will be replaced with a DN 900 mm steel pipe. The powerhouse will be refurbished to adjust for the increased capacity of the electro-mechanical equipment.



Agatobwe powerhouse and penstock

Energy Production

The current design capacity of the plant is approximately 210 kW, yet the only 10-15 kW is produced. Once the plant is connected to the public grid, no longer operating on island mode, with the newly installed electro-mechanical equipment the plant will have a capacity of 405 kW.

Scope of Supply

Malthe Winje Infrapower AS will be responsible for the complete EPC supply to Agatobwe SPV. All the piping, mechanical and electro-mechanical equipment shall be procured and delivered to site by MWIP. The civil works will be conducted by a local civil subcontractor supervised by a Site Manager from MWIP.

ESIA Study

The project is already established, and the impact of steps mentioned above is limited to the current project site. Therefore, an ESIA study is not required.

Project Schedule

The expected project execution time from financial close to commercial operation is scheduled to take place over 15 months. However, MWIP aim to reduce the *construction* time to 6 months. The climate in the project area is suitable for construction.