



Kingdom of the Netherlands



TRAIDE

Challenges encountered by hydro-power dams in Ethiopia and associated business opportunities

TRAIDE Ethiopia



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Introduction

Ethiopia is rich in natural resources and has high potential for renewable energy sources, including hydropower, wind power, geothermal power, solar energy, and biomass. Hydropower dams play a crucial role in the country's energy sector, generating significant amounts of electricity and contributing to renewable energy targets.

However, over the last decade, the country has suffered from chronic electricity shortages due to rapid economic growth outpacing the development of the energy sector.

With this summarized report, we aim to showcase the major challenges negatively impacting the effective functioning of hydropower dams in the country, as well as potential private sector solutions that Dutch companies could consider investing in.



Country Context



Ethiopia is the **second most populous** country in Africa with **123 million** citizens (2022) and a population **growth rate of 2.5%** currently.



The country has one of the fastest-growing economies in the region, with an estimated **growth rate of 6.4%** in FY2021/22.



The country has an **interconnected system (ICS)**. Its main grid system and installed capacities (EEP, 2018):

16 hydropower plants 3,810 MW	3 wind farms 324 MW	6 diesel standbys 99.17 MW	1 geothermal plant 7.30 MW
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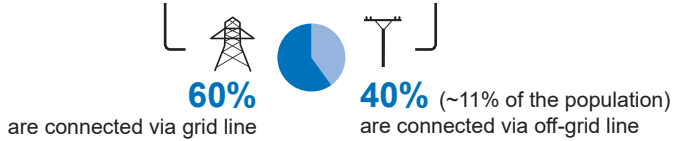
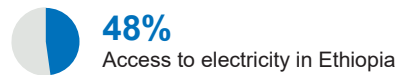


The national power generation **capacity** has shown **impressive growth**:



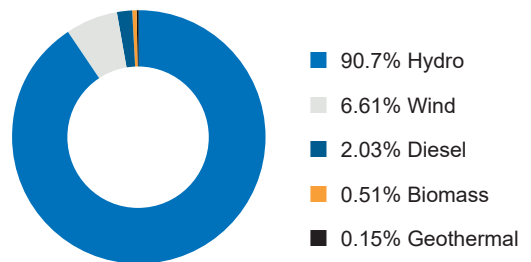
However, Ethiopia has one of the **lowest** levels of annual **energy consumption per capita** in the world (**944 kWh**, 2020), and the majority of the population lives in conditions of relative poverty and **energy insecurity**.

Energy Generation Status



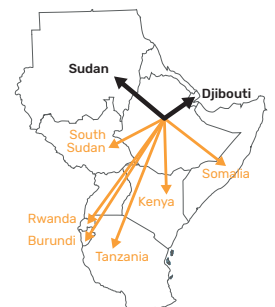
Hydropower gives **90.7%** of Ethiopia's total renewable electricity's source **4,818 MW** installed capacity as of 2023

Figure 1. INSTALLED CAPACITY (MW) OF ICS AS OF 2014 (2021/22 G.C.)



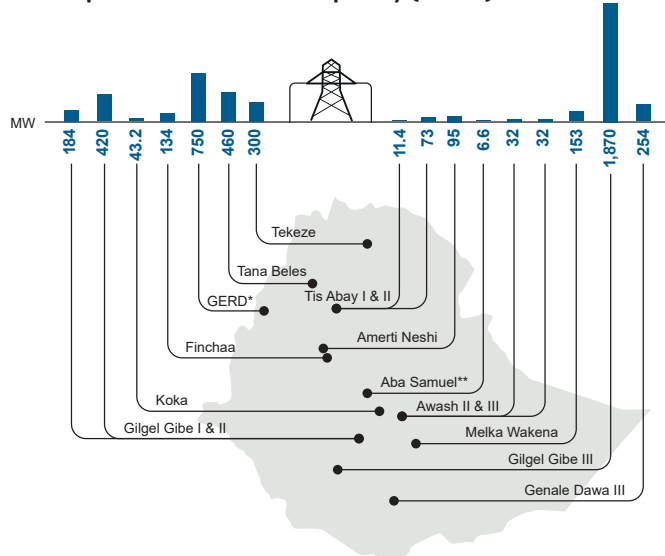
Energy export of Ethiopia*

- Current export destinations
- Planned export destinations



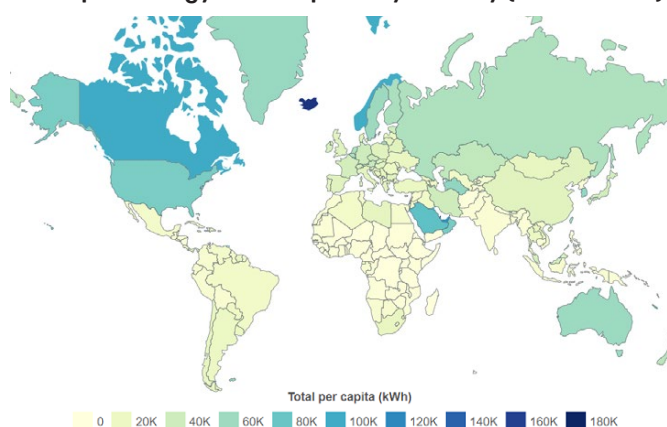
*Map source: Eric Gaba, Wikimedia Commons user Sting, CC BY-SA 3.0

Power plant and installed capacity (in MW)

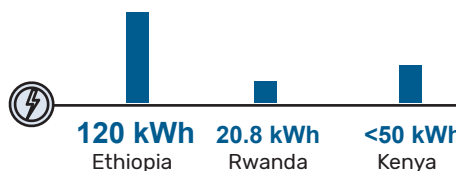


* Grand Ethiopian Renaissance Dam (the two early generation units)
 **Aba Samuel is currently not operational due to compensation issues.

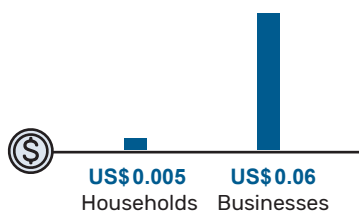
Per capita energy consumption by country (kWh in 2020)



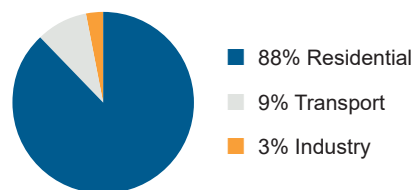
Energy usage by country (kWh per month)



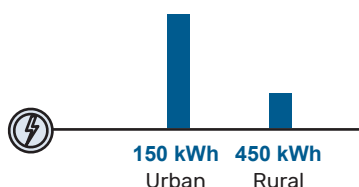
Energy cost for households and businesses (US\$ per kWh)



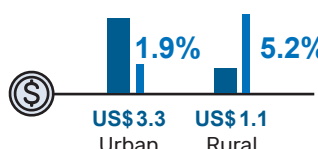
Energy utilization by sector



Households' consumption (kWh per month)



Households' electricity cost (US\$ per month) and its average rate in monthly expenses (%)



Hydropower Potential

- In Ethiopia, only 10% of the hydropower potential is currently being exploited. However, the country possesses the capacity to harness its water resources and generate approximately 45,000 MW of hydropower.
 - Large hydropower plants contribute 88% to Ethiopia's current electricity generation.
 - The topography of Ethiopia, with its mountainous areas coupled with numerous rivers and streams, also makes micro hydropower development suitable. The total potential for micro hydropower (of size less than 500 kW) in the country is estimated to be 100 MW.
- Ethiopia is a water-rich country with several rivers originating from the highlands. Additionally, the country has numerous lakes, particularly in the Great East African Rift Valley, which provide huge potential for hydroelectric power generation.

Figure 2. MAJOR RIVER AND LAKE BASINS OF ETHIOPIA



Issues faced by the Ethiopian hydropower dams and recommended business opportunities

According to the Ethiopian Electric Power (EEP), the electric production in the country has been variable, and most of the dams face challenges that can be addressed in part by the private sector. This includes:



Sedimentation

The soil erosion from upstream areas of the basin and the subsequent sedimentation in the downstream area, including dams and reservoirs, are immense drawbacks and threats that have existed for decades in the country. Therefore, the deposition of large amounts of sediment in reservoirs is the biggest challenge, reducing the capacity and lifetime of the Ethiopian dams.

Research done on Gilgel Gibe catchment in 2007 showed that the reservoir capacity has been reduced by annual sediment loads of $4.50 \times 10^7 \text{ t year}^{-1}$ which could occupy $3.75 \times 10^7 \text{ m}^3 \text{ year}^{-1}$.

EEP employs a combination of sedimentation flushing, maintenance, and environmental measures to clean sediments from the power generation facilities, ensuring the efficient and uninterrupted operation of hydroelectric plants.

BUSINESS OPPORTUNITIES

- Consultancy on dams/reservoirs design with appropriate sedimentation basins or chambers to allow the sediments to settle.
- Supply of equipment to flush out sediments out of reservoirs.
- Supply of equipment for sediment trapping and dredging.
- Investment on commercial plantation of trees at upstream areas and supply seed for deep rooted grasses.



Water hyacinth

Water flows to hydropower dams in Ethiopia have been greatly impacted by invasive water hyacinth. The EEP is trying to combat this issue by implementing manual harvesting, which is costly and labour-intensive. As a result, the EEP is open to exploring innovative solutions for harvesting and controlling the expansion of water hyacinth in partnership with the private sector.

BUSINESS OPPORTUNITIES

- Introduction of innovative solutions fighting and harvesting water hyacinth.
- Introduction of innovative solutions converting water hyacinth into other useful products. Example, supply of equipment and advisory converting the plant into animal feed, biofuel and household utilities.



Concentration of agricultural wastes, such as hay and wooden materials

According to the EEP, concentration of such kind of materials reduce the capacity of hydropower dams by blocking especially the filter at the cooling station.

BUSINESS OPPORTUNITY

Introduction of improved Trash Rack that can better filter small and large sized solid wastes. This provides an improved filtration process before the water enters reservoirs and again as it progresses towards the cooling station.



Floating islands

Floating islands have been a challenge especially at Beles, Gibe and Fincha hydropower dams.

BUSINESS OPPORTUNITY

Tailored to the specific characteristics and challenges of each hydropower dam, Dutch companies could invest in introduction of innovative solutions and advisory services preventing floating Islands. This include, maintenance and inspection of reservoir, environmental and social assessment studies, and installation and maintenance of debris screens.

¹ The Ethiopian Electric Power (EEP) is a public company responsible to undertake the construction and operation of power generation, high voltage transmission lines, and substations. It operates under the federal law of Ethiopia, Regulation 203/2013, and has the objectives of conducting studies, implementing projects, managing operations, and facilitating power sales and leasing.

Cross-cutting opportunities

Supply of equipment and infrastructure development

EEP and the Ministry of Finance are calling for companies to join a PPP. This presents opportunities for engineering, procurement and construction companies providing maintenance solutions, or companies specialising in providing knowledge/technical assistance and companies developing infrastructure such as, sub stations and transmission and Interconnection lines. Companies could rent back the interconnection lines to the EEP.

International calls for bids floated by the EEP, among others, can be found at the EEP website, Ethiopian Herald magazine, and DG market.

Floating solar panels

A feasibility study conducted by the Ethiopian Electric Power (EEP) has shed light on a promising opportunity for the private sector to invest in the installation of floating solar panels and power production at the major hydropower dams located in Ethiopia. This groundbreaking study has revealed that there is immense potential to harness solar energy alongside hydropower, creating a symbiotic relationship that can significantly enhance the country's renewable energy generation capacity.

SUMMARY OF BUSINESS OPPORTUNITIES AND CHALLENGES

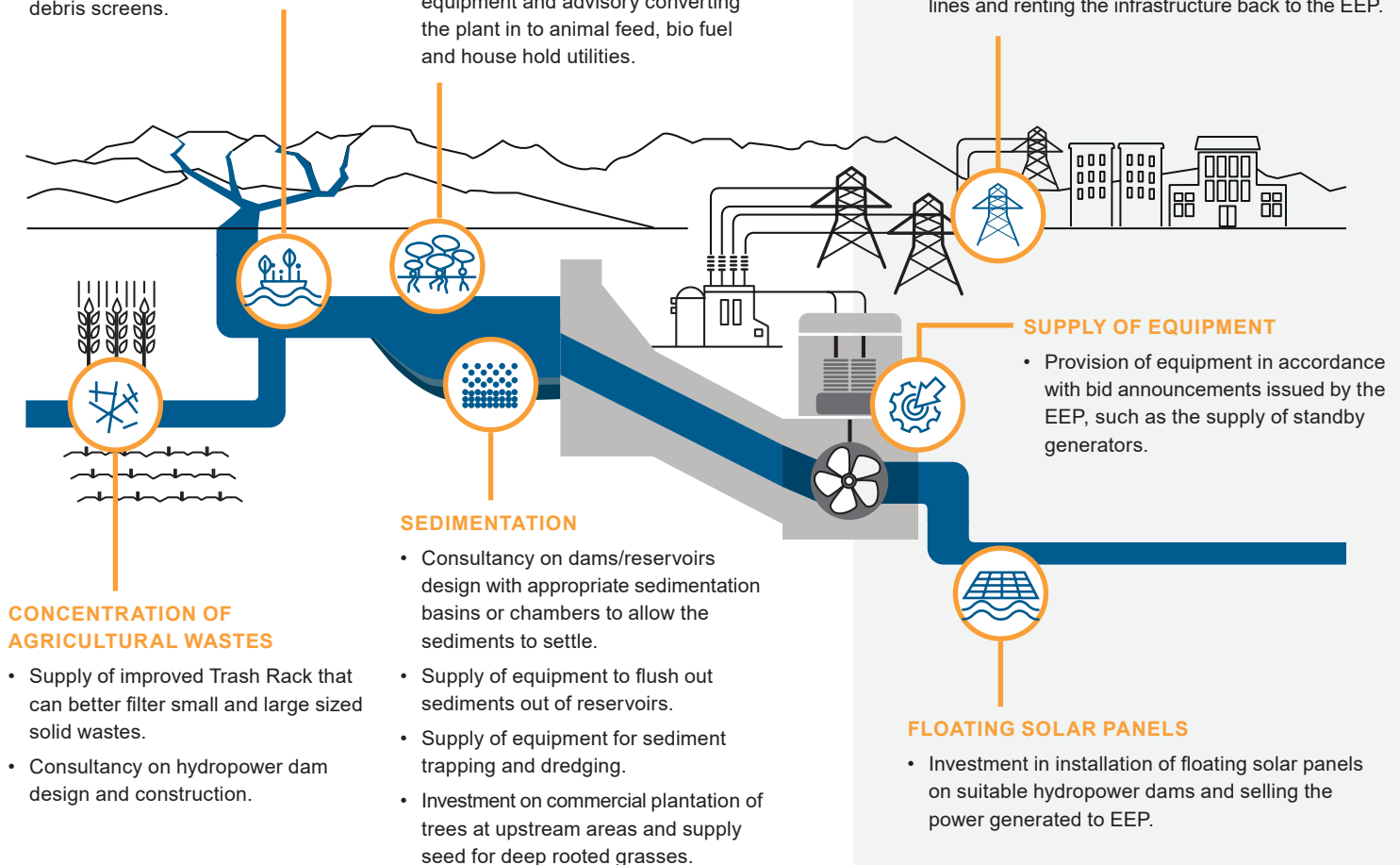
BUSINESS OPPORTUNITIES

FLOATING ISLANDS

- Maintenance and inspection of reservoirs.
- Environmental and social assessment studies.
- Installation and maintenance of debris screens.

WATER HYACINTH

- Introduction of innovative solutions fighting and harvesting water hyacinth.
- Introduction of innovative solutions converting water hyacinth in to other useful products. Example, supply of equipment and advisory converting the plant in to animal feed, bio fuel and house hold utilities.



CONCENTRATION OF AGRICULTURAL WASTES

- Supply of improved Trash Rack that can better filter small and large sized solid wastes.
- Consultancy on hydropower dam design and construction.

SEDIMENTATION

- Consultancy on dams/reservoirs design with appropriate sedimentation basins or chambers to allow the sediments to settle.
- Supply of equipment to flush out sediments out of reservoirs.
- Supply of equipment for sediment trapping and dredging.
- Investment on commercial plantation of trees at upstream areas and supply seed for deep rooted grasses.

CROSS-CUTTING OPPORTUNITIES

INFRASTRUCTURE DEVELOPMENT

- Execution of substation construction.
- Installation of transmission and interconnection lines and renting the infrastructure back to the EEP.

SUPPLY OF EQUIPMENT

- Provision of equipment in accordance with bid announcements issued by the EEP, such as the supply of standby generators.

FLOATING SOLAR PANELS

- Investment in installation of floating solar panels on suitable hydropower dams and selling the power generated to EEP.

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