# Beles Multipurpose Project

# Fig

# The Beles Hydroelectric Power Plant is situated on the shores of Lake Tana, in Amhara regional state, about 370 km north of Addis Ababa.

The main portion of the works of the Beles Multipurpose Project is located underground and is constituted by: the Headrace tunnel (11.8 Km long) conveying water from Lake Tana to the pressure shaft, the underground Powerhouse accommodating four Francis turbine-generator units with the capacity to generate 115 MW each, the Tailrace tunnel (7.2 Km long) discharging the water into the Jehana River. The power plant has a total installed power of 460 MW and an estimated production of 1720 GWh/y.

The **Beles Hydroelectric Power Plant**, sometimes referred to as **Beles II** or **Tana Beles**, is arun of the river hydroelectric power plant in  Ethiopia near Lake Tana . The power plant receives water from the lake through the Tana Beles interbasin transfer and after utilizing it to produce electricity, the water is then discharged into the Beles River. The plant has an installed capacity of 460 MW and it is the second largest power plant in the country. It is also expected to help provide water for the irrigation of 140,000 ha (350,000 acres). It was inaugurated in May 2010 and the last generator was operational in February 2012. Its construction was negatively perceived by downstream Egypt

Background and construction

In 1992, the first feasibility study was complete for the project, a 200 MW power station. A later study and final design was completed in 2005 by Studio Pietrangeli for the current 460 MW plant. The Government of Ethiopia signed a contract with  saline costruttori to build the plant on July 8, 2005 and construction began soon after. Because of the project's remote location, transportation and manning of personnel and equipment was difficult, often taking 4–5 months for supplies to arrive. On June 2, 2007, a  tunnel boring machine (TBM), operated by SELI, began boring the 7.2 km (4.5 mi) tailrace tunnel and completed it on May 31, 2008. Tunneling was carried out seven days a week in three eight-hour shifts a day. The TBM averaged 20 m (66 ft) per day while in January 2008, a maximum daily amount of 36 m (118 ft) was achieved. The TBM for the 12 km (7.5 mi) headrace tunnel broke through, completing it on August 11, 2009. Salini Costruttori awarded a sub contract to construct the actual power station to VA Tech Hydro. On May 11, 2010, the first 115 MW generator at the power plant began operation and on May 14, 2010, the plant was inaugurated. The project's cost was around $500 million  USD. The power plant was fully operational in February 2012

**Design**

The Beles Hydroelectric Power Plant receives water from Lake Tana where it is transferred to a power station and then discharged through another tunnel and into the Beles River. This is first accomplished byan inlet on Lake Tana, where the power station can Utilize 9,120,000,000 m3 (7,390,000 acre⋅ft) of the lake's volume for power production. The inlet channel is 43 m (141 ft) wide, 11.5 m (38 ft) high and its flow into the headrace tunnel is controlled by five  floodgate. The headrace tunnel transfers the water to the southwest along its 12 km (7.5 mi) length within its diameter of 8.1 m (27 ft). At the end of the headrace tunnel, it converts into a 6.5 m (21 ft) diameter and 270 m (890 ft) long penstock before reaching the power station. At the power station, water is delivered to four Francis turbine powering four 115 MW generators The power station is an underground cavern type and is 82 m (269 ft) long, 17.6 m (58 ft) high and 38.5 m (126 ft) wide. It has a 91.2 m (299 ft) deep and 8 m (26 ft) diameter surge shaft as well. Once the water is used in hydroelectric production it is then discharged from the power station to the Beles River via a 7.2 km (4.5 mi) tailrace tunnel with the same diameter as the headrace. Normal water level at the inlet is 1,800 m (5,900 ft) above sea level and the power station resides at 1,450 m (4,760 ft), allowing for 350 m (1,150 ft) of  hydraulic head The project is also expected to help irrigate 140,000 ha (350,000 acres) in the future as well.

# Grand Ethiopian Renaissance Dam Project

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The project is located approximately 500 km north west of the capital Addis Ababa, in the region of Benishangul - Gumaz along the Blue Nile. At the end of the works, the Grand Ethiopian Renaissance Dam will be the largest dam in Africa: 1,800 m long, 155 m high and with a total volume of 74,000 million m³.

The project involves the construction of a main dam in Roller Compacted Concrete (RCC), with 2 power stations installed at the foot of the dam. The power stations are positioned on the right and left banks of the river and comprise 16 Francis turbines with a total installed power of 6,000 MW and estimated production of 15,000 GWh per year. The project is completed by a 15,000 m3/s capacity concrete spillway and a rockfill saddle dam 5 km long and 50 m high, both located on the left bank.

The **Grand Ethiopian Renaissance Dam** (**GERD**  formerly known as the **Millennium Dam** and sometimes referred to as **Hidase Dam**, is a  gravity dam on the  Blue Nile River in Ethiopia that has been under construction since 2011. It is in the Benishangul-Gumuz region  of Ethiopia, about 15 km (9 mi) east of the border with Sudan at 6.45 gigawatts, the dam will be the largest hydroelectric power plant in Africa when completed, as well as the 7th largest in the world. As of August 2017, the work stood at 60% completion. Once completed, the reservoir will take from 5 to 15 years to fill with water

**Background**

The eventual site for the Grand Ethiopian Renaissance Dam was identified by the United States bureau of reclamation during a Blue Nile survey conducted between 1956 and 1964. The Ethiopian Government surveyed the site in October 2009 and August 2010. In November 2010, a design for the dam was submitted. On 31 March 2011, a day after the project was made public, a US$4.8 billion contract was awarded without competitive bidding to saline costruttori and the dam's foundation stone was laid on 2 April 2011 by then Prime Minister Meles Zenawi A rock crushing plant has been constructed along with a small air strip for fast transportation. The first two generators are expected to become operational after 44 months of construction. Egypt, which lies downstream, opposes the dam which it believes will reduce the amount of water that it gets from the Nile. Zenawi argued, based on an unnamed study, that the dam would not reduce water availability downstream and would also regulate water for irrigation. In May 2011, it was announced that Ethiopia would share blueprints for the dam with Egypt so the downstream impact could be examined.

The dam was originally called "Project X", and after its contract was announced it was called the Millennium Dam. On 15 April 2011, the Council of Ministers renamed it Grand Ethiopian Renaissance Dam. Ethiopia has a potential for around 45 GW of hydropower. The dam is being funded by government bond and private donations. It was slated for completion in July 2017.

The potential impacts of the dam have been the source of severe regional controversy. The Government of Egypt, a country which relies heavily on the waters of the Nile, has demanded that Ethiopia cease construction on the dam as a preconditions to negotiations, sought regional support for its position, and some political leaders have discussed methods to sabotage it. Egypt has planned a diplomatic initiative to undermine support for the dam in the region as well as in other countries supporting the project such as China and Italy. However, other nations in the Nile basin initiative have expressed support for the dam, including Sudan, the only other nation downstream of the Blue Nile, which has accused Egypt of inflaming the situation. Ethiopia denies that the dam will have a negative impact on downstream water flows and contends that the dam will in fact increase water flows to Egypt by reducing evaporation on Lake Nasser. It has accused Egypt of being unreasonable; Egypt is demanding to increase its share of the Nile's water flow from 66% to 90%.

**Cost and financing**

The Ethiopian government has stated that it intends to fund the entire cost of the dam by itself. It has issued a bond targeted at Ethiopians in the country and abroad to that end. The turbines and associated electrical equipment of the hydropower plants costing about US$1.8 billion are reportedly financed by Chinese banks. This would leave US$3 billion to be financed by the Ethiopian government through other means. The estimated US$4.8 billion construction cost, apparently excluding the cost of power transmission lines, corresponds to about 5% of Ethiopia’s Gross Domestic Product of US$87 billion in 2017.

**Design**

The design changed several times between 2011–2017. This affected both the electrical parameters and the storage parameters.

Originally, in 2011, the hydropower plant was to receive 15 generating units with 350 MW  nameplate capacity each, resulting in a total installed capacity of 5,250 MW with an expected power generation of 15,128 GWh per annum. However, due to the upgrading made on the power plant, its generation capacity was uplifted to 6,000 MW from 5,250 MW, with a power generation of 15,692 GWh per annum through 16 generating units with 375 MW nameplate capacity each. In 2017, the design has again been changed to add another 450 MW, with a power generation of 16,153 GWh per annum. That was achieved by upgrading 14 of the 16 generating units from 375 MW to 400 MW without changing the nameplate capacity.

Not only the electrical power parameters were to change over time, but also the storage parameters. Originally, in 2011, the dam was considered to be 145 m (476 ft) tall with a volume of 10.1 million m3. The reservoir was considered to have a volume of 66 km3(54,000,000 acre⋅ft) and a surface area of 1,680 km2 (650 sq mi) at full supply level. The rock-filled  saddle dam besides the main dam was considered to have a height of 45 m (148 ft) meters and a length of 4,800 m (15,700 ft) and a volume of 15 million m3.

In 2013, an Independent Panel of Experts (IPoE) assessed the dam and its technological parameters. At that time, the reservoir sizes were changed already. The size of the reservoir at *full supply level* went up to 1,874 km2 (724 sq mi) (plus 194 km2). The storage volume at *full supply level* had increased to 74 km3 (60,000,000 acre⋅ft) (plus 7 km3). These numbers did not change anymore after 2013.

After the IPoE made its recommendations, in 2013, the dam parameters were changed to account for higher flow volumes in case of extreme floods: a main dam height of 155 m (509 ft) (plus 10 meters) with a length of 1,780 m (5,840 ft) (no change) and a dam volume of 10.2 million m3 (plus 0.1 million m3). The outlet parameters did not change, only the crest of the main dam was raised. The rock saddle dam went up to a height of 50 m (160 ft) (plus 5 meters) with a length of 5,200 m (17,100 ft) (plus 400 meters). The volume of the rock saddle dam increased to 16.5 million m3 (plus 1.5 million m3)

**Gilgel Gibe I Dam**

The **Gilgel Gibe I Dam** is a rock-filled  embankment dam on the Gilgel Gibe river in Ethiopia   . It is located about 57 km (35 mi) northeast of  Jimma in Oromia Region. The primary purpose of the dam is Hydroelectric power production. The Gilgel Gibe I hydroelectric powerplant has an installed capacity of 184  MW, enough to power over 123,200 households.The dam is 1,700 m (5,600 ft) long and 40 m (130 ft) tall. Construction on the dam began in 1988 but work was halted in 1994. In 1995 construction restarted with a new construction firm. The power station was commissioned in 2004.

Water from the dam is diverted through a 9.2 km (5.7 mi) long tunnel to an underground power station downstream. The waters after power generation are discharged back into the Gilgel Gibe River to flow downstream northwards for roughly 2 km only to enter a 26 km (16 mi) long tunnel through a mountain ridge to an underground power station plant ( **Gilgel Gibe II power station** ) at the lower-lying Omo River .

**Gilgel Gibe II Power Station**

The **Gilgel Gibe II Power Station** is a  hydroelectric power station on the Omo River  in Ethiopia . It is located about 80 km (50 mi) east of  Jimma in  Oromia Region. The power station receives water from a tunnel entrance 7055’27”N 37023’16”E on the Gilgel Gibe River . It has an installed capacity of 420 MW and was inaugurated on January 14, 2010. Almost two weeks after inauguration, a portion of the head race tunnel collapsed causing the station to shut down. Repairs were completed on December 26, 2010

**Design**

The Gilgel Gibe II consists of a power station on the Omo River that is fed with water from a headrace tunnel and  sluice gate on the Gilgel Gibe River. The headrace tunnel runs 26 km (16 mi) under the Fofa Mountain and at its end, it converts into a penstock with a 500 m (1,600 ft) drop. When the water reaches the power station, it powers four  pelton turbine that operate four 107 MW  generators. Each turbine is 3.5 m (11 ft) in diameter.

**Construction**

Construction on the power plant began on March 19, 2005, with saline costruttori  as the main contractor. The power station was originally slated to be complete in late 2007 but was delayed because engineering problems encountered during construction. In March 2005, the contract to excavate the tunnel was awarded to  seli and in October 2006, a  tunnel boring machine (TBM) hit a fault, delaying the project. On June 9, 2009, both TBMs met each other and the tunnel was ready for hydraulic testing that September. The tunnel is "considered one of the most difficult tunnel projects ever undertaken, due to the critical, and in some reaches, exceptionally adverse, ground conditions." The power station was inaugurated on January 14, 2010.