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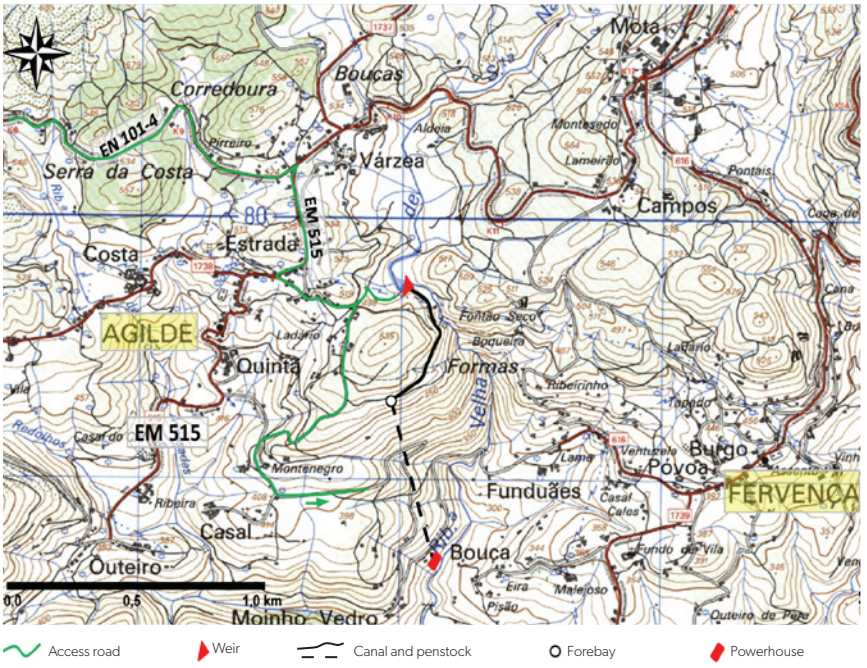
PROJECTOS ENERGÉTICOS

AGILDE HYDROPOWER SCHEME

Stream Santa Natália
Municipality of Celorico de Basto

CELORICO DE BASTO



The Agilde hydropower scheme (SHP) is located on the Santa Natália stream, a right-bank tributary of the Tâmega River, in the parishes of Agilde and Fervença, Municipality of Celorico de Basto. The construction of the scheme started in April 2011 and the beginning of the commercial operation took place in October 2012.

The Agilde SHP is a run-of-river facility, with a small storage capacity (pondage) in the hydraulic circuit for concentration of inflows below the minimum flow compatible with the turbine operation. The hydraulic circuit develops between the elevations 476.50 m and 275.00 m, corresponding, respectively, to the normal retention level, NRL, in the reservoir (head over the water intake rack of 40 cm) and to the axis of the turbine jets.

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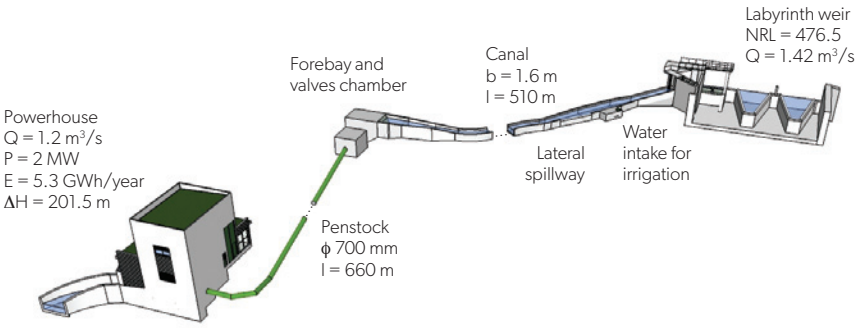
This hydropower plant was designed for a maximum discharge of 1.42 m^3/s, including energy production and irrigation needs, and a maximum gross head, relative to the NRL, of nearly 201.50 m, to which corresponds an installed capacity of 2.0 MW. The mean annual energy production (5.3 GWh) is fed into the national electricity grid at the Fervença-Celorico de Basto electrical line, through a 15-kV interconnection line with a length of 0.5 km.

The scheme consists of a small concrete weir with a maximum height of 6.5 m (elevation of the top of the lateral abutments minus the minimum elevation of the foundation), without flow regulation, provided with a labyrinth spillway chute along a 15-m wide span. The labyrinth crest is 2.5 m

Weir and labyrinth spillway chute. Upstream view

high from the foundation slab, and develops along ca. 50 meters, i.e., it is more than three times longer than the span in which it is inserted. This way, in flood situations, the rising of water level upstream of the weir will be much the same as before the construction of the scheme.

The weir is provided with a bottom discharge, equipped with a 0.70 x 0.70 m^2 sluice gate, operated from a platform installed at the same elevation of that of the top of the lateral abutments of the weir, and with a non-closable orifice (ϕ 160 mm) meant for the free ecological discharge of 20 l/s. The Tyrolean-type water intake is installed at the right abutment of the weir and is protected by two racks, each with 1.70 x 1.70 m^2 and a 20% slope towards downstream to ensure self-cleaning ability.



The hydraulic circuit develops along the right bank of the Santa Natália stream. In the initial reach of the circuit, the systems designed to control the flows diverted in excess (lateral spillway) and to remove water-borne debris (pebble-removing and desilting plants) are installed. While the pebble-removing plant is installed next to the weir, the desilting plant and the lateral spillway are installed about 50 m downstream of the weir and have a length of nearly 30 m. Located at the desilting plant lateral wall adjacent to the stream are the irrigation water intakes, consisting of three orifices provided with valves for control of the diverted flows.

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The reinforced concrete diversion canal, with rectangular section and a bottom width of 1.60 m, runs from downstream of the lateral spillway to the forebay, in an extension of 430 m. It has side walls with horizontal top edge and a height varying between 1.30 e 1.70 m in order to ensure the necessary storage volume (pondage). The canal is provided with three overhead passages for vehicles, or people, and with a rescue ramp.

The forebay, at the downstream end of the canal, has a horizontal area of 40 m^2 and a maximum depth of 4.10 m relative to the outside surface of the top slab. It is provided with a fixed trash rack, with cleaning system, along a 2.80 x 1.60 m^2 span.

Weir, desilting plant, lateral spillway and water intakes for irrigation

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1. Diversion canal
2. Downstream end of the canal and forebay
3. Penstock. Upstream view
4. Penstock. Downstream view

The diverted flow is controlled through a water level control system installed in the forebay, which transmits the data collected to the electrical module of the turbine governor installed in the powerhouse, which, in turn, governs the opening of the injectors.

Next to forebay is the valves chamber, where, among other equipment and electrical installations, a butterfly valve (ϕ 700 mm) is installed for isolation and safety of the penstock.

The penstock is composed of spiral welded steel piping (ϕ 700 mm), and is supported by anchor blocks, lying on open trenches or natural ground, being buried at cross-passages and crossroads and at its end stretch close to the powerhouse.

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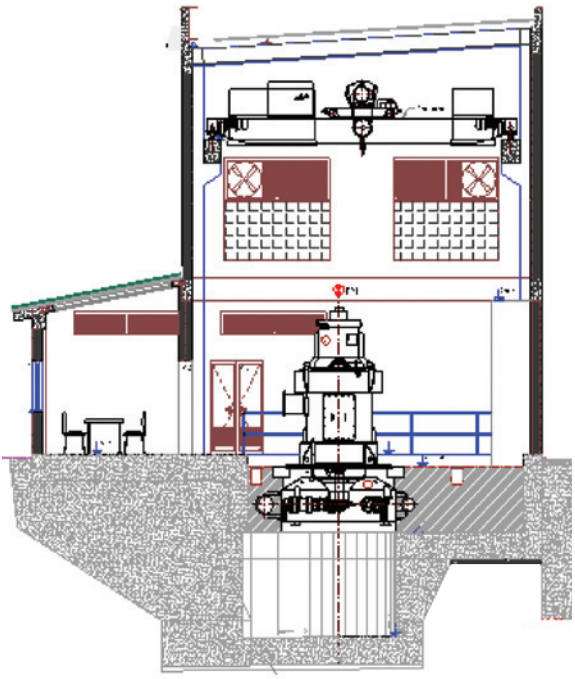
The powerhouse, located at the right bank of the stream Santa Natália, has a horizontal area of ca. 158 m^2 and consists mainly of one single floor, at the elevation of 276.10 m. The electrical protection, signalling and automation panels, as well as the main and auxiliary transformers (2 430 kVA and 50 kVA, respectively) are installed at that same elevation, the turbine-generator unit being located in a lowered area, at the elevation of 275.80 m. The powerhouse is further equipped with the overhead travelling crane for heavy equipment handling, the butterfly valve, ϕ 700 mm, for protection and isolation of the turbine, the penstock drainage system and the discharge pit. The protection systems and the auxiliary transformer, as well as the supporting facilities (storing room, office and sanitary installations) have their own compartments inside the building.



Powerhouse

The generating unit consists of a vertical-shaft Pelton turbine, with six jets and an installed capacity of 2.0 MW, and of a synchronous 2 430-kVA generator, also with a vertical shaft. The 6.6/15-kV main transformer is installed in an external compartment adjacent to the powerhouse.

The powerhouse is automatically operated from a supervisory control and data acquisition (SCADA) system, through which operation data are transmitted to a remote control desktop, and any anomalies are sent out to the powerhouse operator. It is therefore an unmanned facility that, unless persistent faults occur, automatically reconnects to the national electricity grid.

The Agilde hydropower scheme was designed and constructed in order to ensure a successful local environmental and landscape integration, including with respect to the surrounding agricultural and forest components and to the roads nearby. In particular, much care was taken to maintain the uses of the river reach upstream of the weir as far as possible in the same conditions as those occurring before the construction of the scheme, with the implementation of a design solution – the labyrinth spillway chute – perhaps more expensive, but adequate to that purpose.

1. Turbine-generator unit
2. Turbine wheel with the six jets
3. Butterfly valve for the turbine protection
4. Main transformer

TECHNICAL DATA

Hydrological characteristics	
Main watershed / watercourse	Tâmega / Santa Natália stream
Watershed area	16.2 km^2
Mean annual flow	22.7 hm^3
Non-diverted mean annual flow	21.5 hm^3
100-year design flow (weir section)	90 m^3/s
Hydraulic diversion	
Weir	gravity profile and labyrinth spillway chute
Normal Retention Level (NRL)	476.5
Maximum height of the labyrinth crest	4.0 m
Water intake	tyrolean-type
Design discharge	1.20 + 0.22 = 1.42 m^3/s
Canal downstream of the lateral spillway – section / length	rectangular (1.60-m bottom width and 1.50-m average height) / 430 m
Forebay – turbine regulation level / racks area	474.30 / 2.80 x 1.60 m^2
Penstock – diameter / length	700 mm / 660 m
Powerhouse	unmanned, automated operation
Turbine – type / capacity	vertical Pelton turbine, 6 jets / 2 000 kW
Generator – type / power	synchronous / 2 430 kVA
Elevation of the axes of the turbine jets	275
Maximum gross head relative to NRL / at the regulation level in the forebay	201.5 m / 199.3 m
Installed capacity	2 000 kW
Mean annual energy production	5.3 GWh
Connection to the electricity grid	
Main transformer 6.6 kV / 15 kV	2 250 kVA
Interconnection line (15 kV)	0.5 km
Supply voltage	15 kV

General Coordination: HIDROERG – Projectos Energéticos, Lda.
Design: AQUALOGUS – Consultores de Hidráulica e Recursos Hídricos, Lda.
Civil Works: SOCOPUL – Sociedade de Construções e Obras, S.A.
Hydromechnical, Electromechanical and Electrical Equipment: General Contractor: EFACEC – Engenharia e Sistemas, S.A. / Suppliers: RAINPOWER, WEG
Interconnection to the Electricity Grid: EMTE – Empresa de Montagem para Telecomunicações e Electricidade, Lda.
Supervision of the Contracts: PENGEST – Planeamento, Engenharia e Gestão, Lda.