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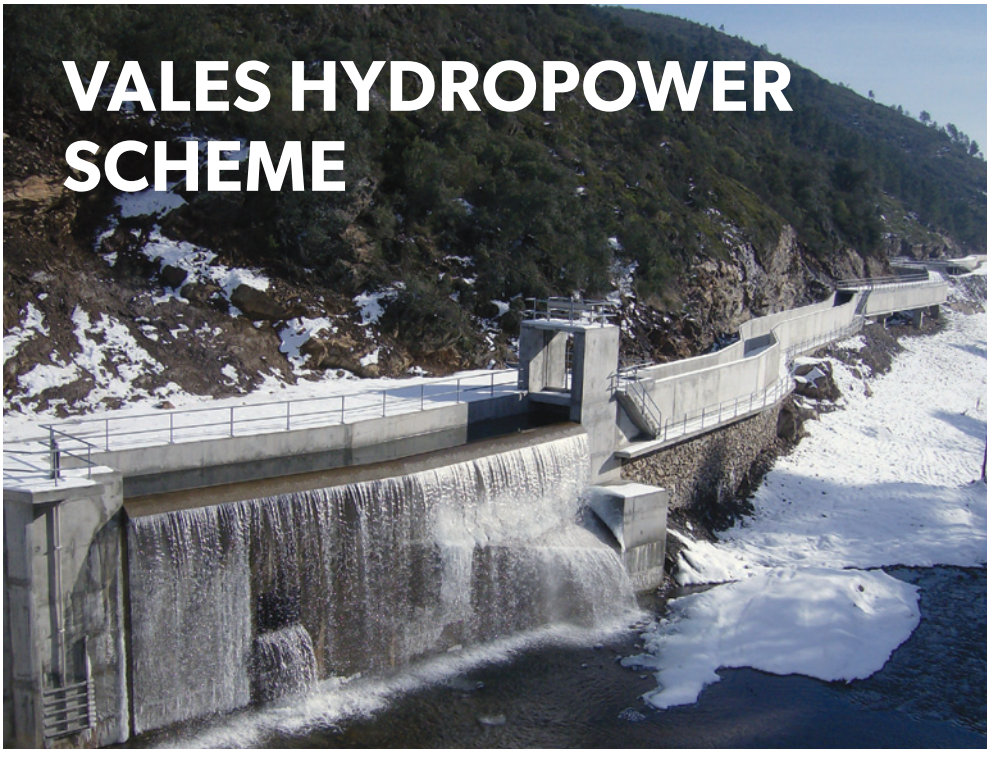
EÓLICAS DO ALTO TÂMEGA E BARROSO, LDA

BULGUEIRA AND CHÃ DO GUILHADO WIND FARMS



VALES HYDROPOWER SCHEME

RIBEIRA DE PENA

VILA POUCA DE AGUIAR

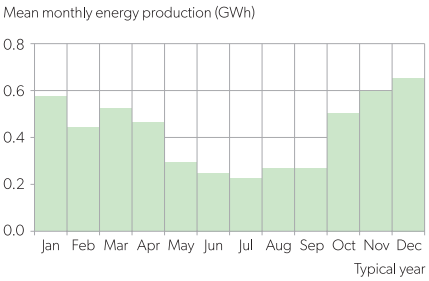
ATBERG – Eólicas do Alto Tâmega e Barroso, Lda., a private limited company, was incorporated in June 2001 for the purpose of building, managing and operating wind power plants, as well as of carrying out any related activities in the field of the renewable energies. The shareholders of ATBERG are the six Municipalities of Alto Tâmega e Barroso region (40%), LUSITERG – Gestão e Produção Energética, Lda. (40%) and HIDROERG – Projectos Energéticos, Lda. (20%).

ATBERG is the owner of the three power plants presented here, which were exclusively designed for the electricity production from renewable natural resources – wind and water: the Bulgueira and Chã do Guilhado Wind Farms and the Vales Hydropower Scheme.

The **Bulgueira Wind Farm**, in operation since March 2003, is located on the Alvão Mountain, Alto de Entre-Águas hill, in a non-protected area, approximately 1 km southeast of the geodesic landmark of Bulgueira, near the Trandeiras village, in the parish of Santa Marinha, Ribeira de Pena Municipality, district of Vila Real.

Basically, this wind farm consists of three wind turbines NORDEX N50/800 kW, positioned in order to make the best possible use of the local winds along a NW/SE axis, at a distance of ca. 125 m from each other and at an altitude of around 1 050 m. The total installed capacity of 2.4 MW is meant for an estimated mean annual energy production of 5.0 GWh/year.

Alto de Entre-Águas. View over the Tâmega River valley



Wind turbines in Bulgueira Wind Farm. Energy production

Each wind turbine includes a horizontal-axis rotor and is equipped with three blades of variable pitch, each one with a length of 23.3 m and automatic declination of the rotor in the wind direction. With a diameter of 50 m, every rotor sweeps an area of 1 964 m^2. The rotation speed is 23.75 rpm for a nominal wind speed of 15 m/s. The cut-in and cut-off wind speeds are 3-4 m/s and 25 m/s, respectively. Two breaking systems are provided, both being able to stop the wind turbine separately.

The turbines are supported by tubular conical steel towers, for a hub height above the ground of 55 m, approximately.

Each of the three wind turbines is equipped with a horizontal-shaft asynchronous generator, with a rated power of 800/200 kW and coupled to the secondary shaft of the gearbox.

In addition to the inside accesses and to the landings surrounding the wind turbines, the wind farm is still provided with a small building that houses the control and the governing equipment. Nearby is the 10/60-kV step-up substation, which includes the gantry tower supporting the line for interconnection with the national electricity grid.

The energy produced is fed into the grid through the 60-kV line "Covas do Barroso/PC de Soutelo de Aguiar", using the 1 700-m line that connects the wind farm to the referred 60-kV line.

Bulgueira Wind Farm

The **Chã do Guilhado Wind Farm**, in operation since October 2009, is located on the Padrela Mountain, outside any protected area, close to the geodesic landmark of Guilhado, ca. 750 m north of the village of Guilhado, in the parish and Municipality of Vila Pouca de Aguiar, district of Vila Real.

The wind farm consists of one wind turbine ENERCON E-82, erected at an altitude of 1 010 m and having an installed capacity of 2.0 MW, meant for an estimated mean annual energy production of 6.0 GWh/year.

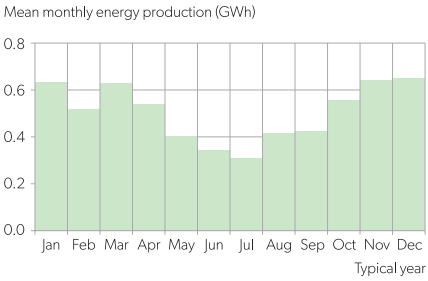
The wind turbine includes a horizontal rotor and is equipped with three blades of variable pitch, each with a length of 38.8 m. With a diameter of around 82 m, the rotor sweeps an area of 5 281 m^2. The rotation speed is variable, ranging from 6 to 20.5 rpm. The cut-in wind speed is 2.5 m/s and the cut-off wind speed varies between 28 and 34 m/s.

The wind turbine concept is based on wind energy conversion without gearbox, the turbine driving directly a synchronous three-phase generator (400 V, 50 Hz).

The wind turbine is supported by a precast reinforced concrete tubular conical tower, for a hub height of about 78 m above the ground.

In addition to the inside accesses and to the landings surrounding the wind turbines, the park is still provided with a small building that houses the control and the governing equipment. Nearby is the tower supporting the line that connects the wind farm to the national electricity grid.

The energy produced is fed into the grid through the 30-kV line "Soutelo/Murça", using the ca. 1 300-m line that connects the wind farm to the referred Soutelo/Murça line.



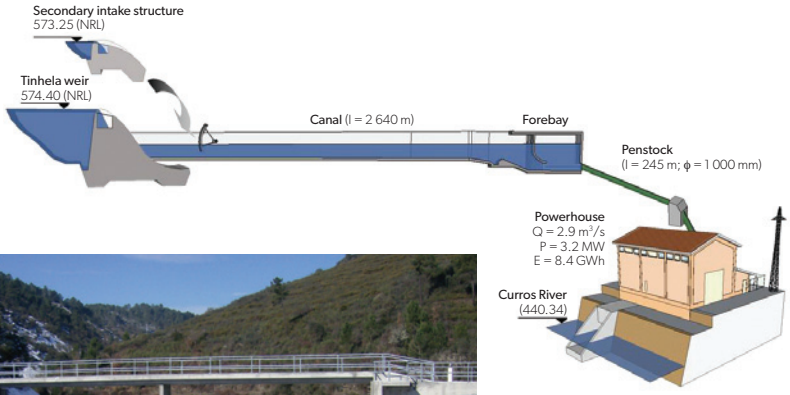
Wind turbine in Chã do Guilhado Wind Farm. Energy production

Chã do Guilhado Wind Farm

The **Vales Hydropower Scheme**, exclusively designed for electricity production, is located in the Municipality of Vila Pouca de Aguiar, on the upstream reach of the Tinhela River (a right-bank tributary of the Tua River, in the Douro River watershed). A small tributary, the stream Chã do Meio, is also diverted. The turbine discharges to the Curros River, quite near its confluence with the Tinhela River.

The construction of the scheme started in December 2006 and the first interconnection of the power plant with the national electricity grid took place in December 2008.

The Vales hydropower scheme was designed for a maximum discharge of 2.9 m^3/s, a maximum gross head of ca. 134.0 m and an installed capacity of 3.2 MW, meant for a mean annual energy production of 8.4 GWh. In overall terms, the scheme consists of a main weir on the Tinhela River, a secondary diversion on the stream Chã do Meio, an open canal, running between the main weir and the forebay and connected to the secondary diversion through an intermediate aqueduct, the referred forebay, the penstock, the powerhouse, the adjacent transformers yard and the grid interconnection line.



Weir on the Tinhela River. View over the lateral spillway

The design of the weirs is based on overtoppable gravity profiles provided with Creager-type spillway chutes, with crests located at the corresponding normal retention levels and designed for 100-year peak flood discharges.

The spillway chute on the River Tinhela, at the elevation of 574.40 m and with a length of 21 m, was designed for a flow discharge of 258 m^3/s. As to the secondary intake, the corresponding design values are 573.25 m, 5 m and 37 m^3/s. The weirs are 14.7-m and 5.3-m high above the foundation. Only the main weir creates a small reservoir, submerging an area of about 0.6 ha but without flow regulation capacity.

The weirs are provided with water intakes for the hydraulic diversions and for the ecological discharges. The main water intakes are of the Tyrolean type and are equipped with protection racks with a 20% downstream slope. The water intakes for the ecological discharges consist of submerged, non-closable circular orifices designed to ensure the prior discharge of the ecological flows, with a total value of 80 l/s. A canal was left inside the right abutment of the main weir and it will be used, if necessary, in the construction of a fish ladder. The weir is still provided with a maintenance discharge system. In the initial reach of the hydraulic circuit, downstream of the weir, a lateral spillway was built to return to the river the flows diverted in excess, under flood situations.

Hydraulic circuit downstream of the weir on the Tinhela River. From upstream to downstream: sluice gate of the pebble-removing system, lateral spillway and maintenance discharge, operating mechanism of the flat gate designed to isolate the diversion canal and initial reach of such canal

The concrete diversion canal between the lateral spillway next to the Tinhela weir and the forebay, has a length of around 2 640 m, a slab slope of 0.05% and a rectangular section. It has lateral walls with horizontal top edge, a bottom width of 2.2 m and variable height up to 2.76 m. At its most upstream reach, the canal is provided with a flat gate, 1.85 x 2.30 m^2, for isolation purposes. About 220 m from its beginning, the canal intercepts the aqueduct that conveys the diverted flows from the secondary diversion. Immediately downstream of such interception point, the canal is provided with an automatic water level control gate, AVIS 110/212, limiting the discharges to the turbine maximum design value of 2.9 m^3/s. The canal is also provided with a lateral spillway, located ca. 1 425 m upstream from the forebay, which operates as a surface spillway whenever an unexpected stop of the turbine occurs. Rescue ramps, with overhead pedestrian crossings, and two crossings for light vehicles are also provided.

The forebay, at the downstream end of the canal, has a horizontal area of 26 m^2 and a maximum height of about 4.7 m. It is provided with a fixed 4.5 x 2.90-m^2 rack, for trapping debris, equipped with a trash-rack cleaner. The diverted flow is controlled by a water level monitoring system, installed in the forebay, which transmits the respective data to the turbine governor, installed in the powerhouse, through which the opening of the injectors is governed.

Adjacent to the forebay is the valves chamber, where, among other equipment and electrical installations, the butterfly valve ϕ 1 000 mm is installed for isolation and safety of the penstock, such valve being equipped with an automatic overspeed closing device.

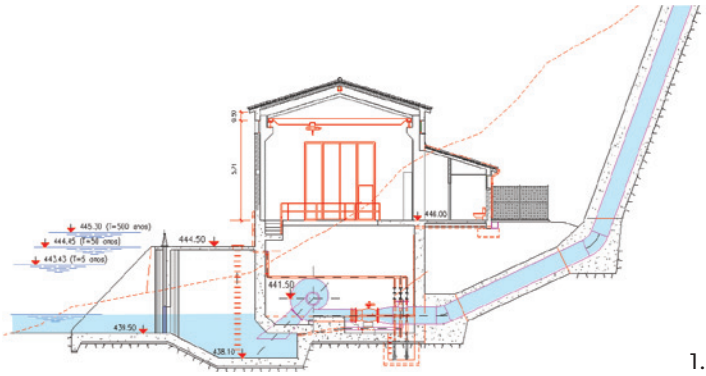
The penstock develops between the elevations 568.60 m and 439.60 m, is about 245 m long and consists of a welded steel piping ϕ 1 000 mm, not buried and supported by concrete blocks equidistant from each other by ca. 10 m. It is further supported by five anchor blocks, of which the last three, near the powerhouse, are concrete embedded.

1. View, towards downstream from the secondary intake, over the aqueduct and the diversion canal
2. View from the forebay towards upstream: trash-rack cleaning mechanism and, further ahead, the diversion canal
3. Construction of the forebay

Penstock and powerhouse. Construction phase

Penstock and powerhouse

The powerhouse of the Vales hydropower scheme is an open-air building, on the right bank of the Curros River, ca. 250 m upstream from its confluence with the Tinhela River. It consists of three floors, with a total inside area of around 300 m^2. In the entrance floor, at the elevation 446.0 m, i.e., clearly above the exceptional 500-year design flood, are the electric boards for the control, governing, lighting, safety and security of the powerhouse, as well as the assemblage atrium and the auxiliary rooms (sanitary facilities, spare-parts storage and office). The turbine-generator unit, the electro-hydraulic governor and the medium voltage electric boards may be found in an intermediate floor, at the elevation 440.5 m. The powerhouse is still provided with the turbine isolation valve and the respective by-pass circuit, the penstock drainage system, the drainage pit and the lubricating system, the access to which is made through the lower floor, at the elevation 439.5 m. The handling of the equipment inside the powerhouse is ensured by an overhead travelling crane with a load capacity of 20 t.



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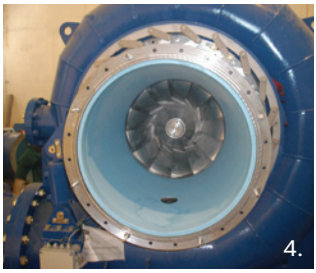

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1. Schematic cross-section of the powerhouse and partial view of the turbine-generator unit showing the distributor opening control system, and, right below the ceiling, the overhead travelling crane
2. Powerhouse and adjacent transformers yard
3. End section of the penstock, butterfly valve, generator, flywheel protection housing, turbine and beginning of the draft tube
4. Spiral case and opening system of the distributor blades, turbine runner, and exit of the runner balance pipe

The turbine-generator unit consists of a horizontal-shaft Francis turbine with a simple runner, for a speed of 1 000 rpm and a capacity of 3.2 MW, and of a horizontal-shaft 6.6-kV synchronous generator, 3 750 kVA. The protection and isolation of the turbine are ensured by a butterfly valve ϕ 700 mm. The connection of the welded steel draft tube to the River Curros is made through an excavated gallery and a tailrace with variable bottom slab elevation. The penstock emptying system also terminates in this same gallery.

The transformers yard, adjacent to the powerhouse building, has a horizontal area of nearly 51 m^2, is fenced by a metallic net, and it includes the main 6.6/30-kV transformer, 3 750 kVA, and the auxiliary transformer. The interconnection with the national electricity grid is made between Telheira and Murça, through a 30-kV line connecting the substations of Valdigem and Vila Pouca de Aguiar. A single 30-kV line, 8 km long and made of aluminium-steel conductors with a nominal section of 90 mm^2, was erected to connect the power plant to the referred grid line.

Under normal operation conditions, the Vales power plant is unmanned and automatically operated. The various equipment are supervised and controlled through a SCADA system installed in the powerhouse. The turbine distributor regulation and the start-up and shutdown sequences of the turbine-generator unit are controlled by the water level in the forebay. The status of the equipment inside the powerhouse is permanently monitored by a telecommunication system that transmits to the powerhouse operator, via a card modem connected to the PLC and via the local mobile phone network, the signals that will enable him to identify, from a long distance, any equipment malfunctions.

The environmental and landscape integration of the Vales hydropower scheme emerges not only from the design solutions and the construction methods that were adopted in what concerns the hydraulic structures and the powerhouse building, but also from the methods used to open the access roads and to ensure the biophysical recovery of the riparian galleries, of the excavation and landfill slopes, and of the other forested areas affected by the project. Such recovery is subject to the monitoring actions set forth in the concession contract.

TECHNICAL DATA OF VALES SHP

Hydrological characteristics	**Main intake Tinhela River**	**Secondary intake Chã do Meio Stream**
Main watershed and watercourse	Douro River and Tinhela River (a tributary of Tua River)	
Watershed area (km^2)	79.00	5.84
Non-diverted mean annual flow (hm^3)	49.24	1.56
100-year design flow (weir section m^3/s)	257.7	36.9
Hydraulic diversion		
Weir	Gravity profile and Creager-type spillway chute	
Normal retention level (NRL)	574.40	573.25
Height of the spillway crest above the foundation	10.20 m	3.55 m
Water intake	Tyrolean-type	
Design discharge (Qmax)	2.80 m^3/s	0.10 m^3/s
Canal – section / length	Rectangular (2.20-m bottom width and 2.15-m average height) / 2 640 m	—
Forebay – turbine regulation level / net area of the rack	571.20 / 4.50 x 3.086 m^2	
Penstock – diameter / length	1 000 mm / 244 m	
Powerhouse	**Unmanned, automatic operation**	
Turbine – type / capacity	Francis, horizontal shaft / 3.2 MW	
Generator – type / power	Synchronous / 3 750 kVA	
Water level in the tailrace (for Qmax)	440.34	
Design gross / net head	134.06 m / 127.72 m	
Installed capacity	3 200 kW	
Mean annual energy production	8.43 GWh	
Connection to the national electricity grid		
Main transformer 6.6 kV/30 kV	3 750 kVA	
Interconnection line, 30 kV – section / length	Aluminium-steel 90 mm^2 / 8 km	
Supply voltage	30 kV	

General coordination: ATBERG – Eólicas do Alto Tâmega e Barroso, Lda.
Design: CENOR – Projectos de Engenharia, Lda.
Civil works: CONSTRUÇÕES GABRIEL A.S. COUTO, S.A.
Hydromechanical, electromechanical and electrical equipment: EFACEC – Engenharia, S.A.
Connection to the the national electricity grid: SILVA & VINHA, S.A.
Supervision of the contracts: HIDROERG – Projectos Energéticos, Lda. / EHATB – Empreendimentos Hidroeléctricos do Alto Tâmega e Barroso, EIM, S.A.