

Small Hydropower



coba
GROUP

ENGINEERING AND ENVIRONMENTAL CONSULTANTS

PRESENTATION

COBA is a multinational and multidisciplinary group of Engineering and Environmental Consultants, founded in 1962.

The Group provides engineering consultancy services ranging from basic and planning studies, technical, environmental and economic feasibility studies, design and construction design as well as project management and works supervision, to operation follow-up and behaviour monitoring.

The Group has offices/subsidiaries in three continents and experience in more than fifty countries and encompasses several companies in accordance with functional specializations or geographical areas.

The competences acquired along the last six decades, together with the state-of-the-art employee expertise, the stability of its permanent staff and the comprehensive international experience allow to find out the best solutions for the full satisfaction of public and private Clients' needs and expectations.

During its existence, the Group has participated together with public authorities or private developers, in the feasibility of multidimensional projects, some of them being structuring projects and with major impacts on the improvement of peoples' life conditions in the several countries where it worked.

At present, the Group has a wide number of competences and technical areas that allow the composition of multidisciplinary teams who share knowledge and experiences in the execution of projects.

BEGINNING AND EVOLUTION

Since its foundation in 1962, hydroelectric power has been one of COBA's major areas of expertise, given its involvement in the study of hydraulic developments, namely dams for power generation. In the 60's COBA designed the Funil Hydroelectric Power Development, on the Paraíba River in Brazil, with an installed capacity of 216 MW that is operating since 1969. Until the beginning of the 80's approximately 15 hydropower plants were designed, with installed capacities ranging between 40 MW and 520 MW, in Angola, Mozambique, Greece, Brazil, Costa Rica and Portugal. COBA's intervention goes from Feasibility Studies and Design to Technical Assistance to Construction, including the approval of as-built plans for civil works and equipments.

After the 80's, COBA started its activity in small hydropower plants in Continental Portugal and Azores Autonomous Region and in Guinea-Bissau, with installed capacities ranging between 2 MW and 20 MW. This activity continued along the 90's and the 20's with the execution of several studies and designs in Portugal and abroad, some of which already in construction or in operation, consequence of the new legislation introduced in 1998, that favoured the independent power generation through small power plants with a maximum capacity of 10 MW. During this period COBA also began its intervention in the rehabilitation, refurbishment, upgrading and automation of hydropower plants built in the first half of the XX century, in order to enable the operating entities to replace existing equipment by new machinery with improved outputs and to allow for remote control operation. This activity began with the refurbishment and automation of the power plants of the Serra da Estrela Hydropower Development, operating since 1909 and 1959. The implementation of this type of projects involves a very straight interdisciplinary cooperation that is made easy in the case of COBA, since it disposes of staff specialized in all subjects involved.

FIELDS OF ACTIVITY

HYDRAULIC UNDERTAKINGS

Concrete, Earth-fill and Rock-fill Dams. Weirs and Reservoirs Water Conveyance Systems. Hydraulic Structures.

POWER GENERATION AND TRANSMISSION

Hydroelectric Power Plants. Photovoltaic power plants and wind farms. Small Hydropower Plants. Power Plants Rehabilitation and Modernization. Substations High Voltage Transmission Lines. Cooling Water Systems for Thermoelectric Plants.

WATER SUPPLY AND WASTEWATER SYSTEMS

Catchment, Transport and Distribution of Potable Water. Water Treatment Plants. Drainage Systems. Wastewater Treatment Stations. Pumping Stations.

AGRICULTURES AND RURAL DEVELOPMENT

Irrigation and Drainage Systems. Rural Roads. Production Systems. Mapping and Basic Information.

TRANSPORTATION INFRASTRUCTURES

Roads and highways. Railways. Passenger and Freight Railway Stations. Metro and Light Rail. Airports. Bridges and other engineering structures.

ENVIRONMENT

Environmental Impact Assessment. Environmental Management, Monitoring and Auditing. Pollution Control. Landscaping. Land Management. Recovery of Degraded Areas. Waste Landfills.

GEOTECHNICAL STRUCTURES

Tunnels and Caverns. Slopes in Fill and Cut Section. Special Foundations Breakwaters. Embankment Works.

MARITIME AND FLUVIAL WORKS

Wharfs. River Training. Quay Rehabilitation. Flood and Flow Control.

MINING INDUSTRY

Environmental Studies. Design of Tailings Dams and Related Structures. Safety Assessment of Tailings Dams. Design Review of Tailings Dam Closure. Operations Maintenance and Monitoring Manual for Tailings Dams. Risk Analysis. Mine Closure Plan. Training.

BUILDINGS

Residential and Services Buildings. Industrial Buildings. Steel and Mixed Industrial Structures. Rehabilitation and Restoration of Ancient Buildings.

CARTOGRAPHY AND CADASTRE

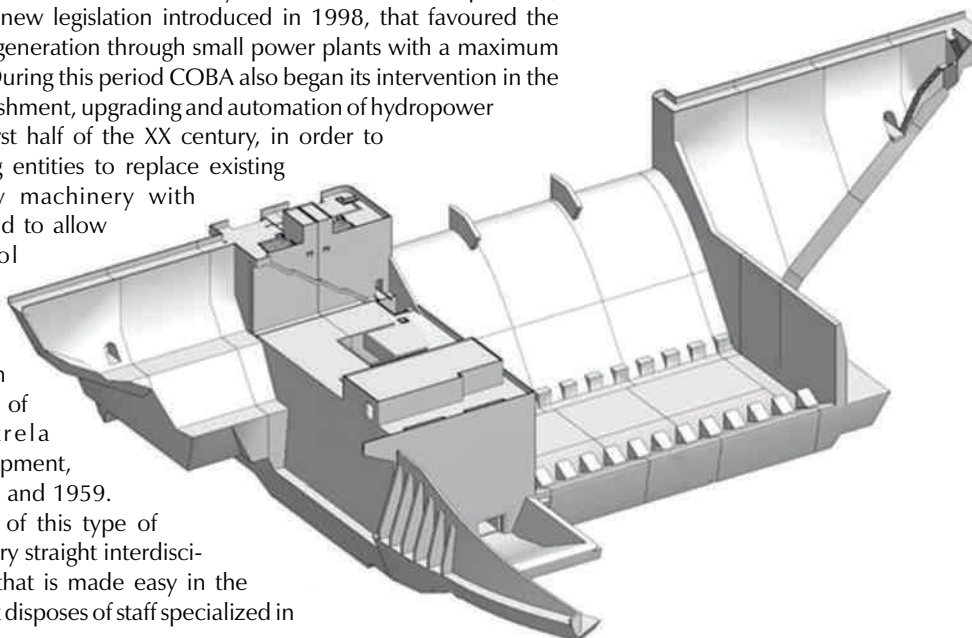
Geographic Information Systems (GIS). Digital Cartography. Thematic Cartography. Thematic Cadastres. Land Acquisition.

SAFETY CONTROL AND REHABILITATION

Expertise, Monitoring. Inspection and Reinforcement of Dams and Transportation Infrastructures. Works Instrumentation. Project Maintenance and Operation.

PROJECT MANAGEMENT AND CONSTRUCTION SUPERVISION

Project Management. Cost Management. Site Supervision. Quality Assurance/Quality Control.



HYDROELECTRIC DEVELOPMENT

BOUÇOAIS - SONIM

The Rabaçal River hydroelectric developments were executed for the contractor ENGIL, SGPS. It includes two stepped developments, one upstream close to Rebordelo village and another downstream close to Bouçoais-Sonim region, in the region of Trás-os-Montes.

The Bouçoais development is composed of a 43 m high and 87 m long crest concrete gravity dam. It is equipped with an overflow spillway for 1500 m³/s, a bottom outlet and a fish lock. The power station underground water conveyance structure is 1300 m long.

The power plant is equipped with two Francis vertical axis units with a capacity of 5000 kW each, designed to turbine 22 m³/s under 53 m net head.

DAM	
Type	Concrete gravity dam
Height	43 m
Crest length	87 m
Dam Volume	19,5 x 10³ m³
Reservoir capacity	1,4 x 10⁶ m³
Maximum flood flow	1500 m³/s
Spillway	overflow, without gates

POWER PLANT
The power station is located on the right bank of the Rabaçal River, about 1,3 km downstream of the dam, taking advantage of the difference in height of about 28 m between the two sites, and has the following characteristics:

Installed capacity	10 000 kW
Head	53 m
Nominal flow	22 m³/s
Number of units	2 Francis turbines
Design flow	22 m³/s
Energy generation	30 Gwh/year

RABAÇAL RIVER - PORTUGAL



WATER CONVEYANCE STRUCTURE
The underground water conveyance structure is installed between the reservoir and the power station, with some 1350 m excavated in the granite formation of the right river bank. The horseshoe tunnel excavation is 4,20 m wide and 4,50 m high.



HYDROELECTRIC DEVELOPMENT

REBORDELO

The Rebordelo development is composed of a 35 m high and 127 m long crest concrete gravity dam. The dam is equipped with a spillway with a maximum capacity 1480 m³/s, a bottom outlet and a fish lock composed by a fish lift and a water intake for the water conveyance structure.

The water conveyance structure connects the reservoir to the power plant and is formed by a 4,20 m wide, 3,75 m high and 1700 m long tunnel and a short penstock with a maximum capacity of 24,4 m³/s. The plant is equipped with vertical axis Kaplan unit with a nominal capacity of 8750 kW.

DAM	
Type	Concrete gravity dam
Height	35 m
Crest length	127 m
Dam volume	19 x 10 ³ m ³
Reservoir capacity	3,13 x 10 ⁶ m ³
Maximum flood flow	1480 m ³ /s
Spillway	overflow, without gates

POWER PLANT
The power plant is located on the right bank of the Rabaçal River, about 1,7 km downstream of the dam, taking advantage of the difference in height of about 20 m between the two sites, and has the following characteristics:

Installed capacity	8 750 kW
Head	42,5 m
Nominal flow	24,4 m ³ /s
Number of units	1 Kaplan turbine
Design flow	24,4 m ³ /s
Energy generation	24 Gwh/year

RABAÇAL RIVER - PORTUGAL



WATER CONVEYANCE STRUCTURE

The underground water conveyance structure is installed between the reservoir and the power station, has a length of some 1700 m and is excavated in the granite formation of the right bank of the river. The horseshoe tunnel excavation is 4,20 m wide and 3,75 m high.



HYDROELECTRIC DEVELOPMENT

TÚNEIS

REHABILITATION AND REFURBISHMENT

The Túneis Hydroelectric Project, exploited by the Azores Electricity Company, comprises Ribeira Quente's major multi-stage development. Built some 50 years ago, it is located near Ribeira Quente, S. Miguel Island in Azores, in a volcanic area with steep slopes, subject to instability phenomena essentially provoked by water circulation processes and softening, erosion and dragging of materials.

It comprises a weir at level (115) in the Tambores stream, a 2320 m long tunnel, a penstock between levels (140) and (53) and a power plant equipped with a 1390 kW Francis Turbine. The intake section covers a 33,2 km² catchment area and a 2137 mm annual average rainfall.

The interventions initially programmed especially envisaged the refurbishment of the hydraulic circuit and the replacement of the energy generating units, as well as the system's remote control system. However, at the end of 1997 and in 1998, torrential rainfalls occurred in the catchment area zone, which led to surface erosion processes and the occurrence of floods and landslides that strongly affected the entire catchment area and all the hydraulic circuits' fundamental elements.

In light of this new situation, the studies and interventions were in a first phase directed to a set of immediate actions envisaging the cleansing, rehabilitation and refurbishment of the plant, thus allowing recommencement of the exploitation activities upon seven months of inactivity and significantly improving the safety conditions of the conveyance structures of the system. The works began in July 1999 and were completed in September 2000. As a result of this upgrading, the development is now equipped with a 1600 kW Francis turbine that generates an average 11 GWh energy/year.



AZORES - PORTUGAL



SMALL HYDROPOWER PLANTS IN THE STATE OF CEARÁ

The studies involved the assessment of available water resources and the technical and economic feasibility studies. They also included the definition of the flow regulating capacities and the estimation of power generation as well as the Terms of Reference for further phases of the studies, namely the Final Design, including the identification of ancillary works, such as topographic and geotechnical field surveys.

The principal objective of the studies was to define the characteristics of six small hydropower plants associated to large weirs or other hydraulic projects in the State of Ceará with capacities ranging from 0,6 MW to 5 MW: Castanhão (4,87 MW); Orós (1,12 MW); Banabuiú (3,48 MW); Aracoiaba (0,42 MW); Jaburú I (0,61 MW); Queda do trecho 1 (0,63 and 1,28 MW).

A technical and economic comparison between alternative solutions was carried out, having led to the conclusion that the implementation of small hydropower plants in the six cases is the most advantageous scenario from an economical point of view.



CEARÁ - BRAZIL



SMALL HYDROPOWER PLANTS IN THE HUAMBO PROVINCE

Feasibility studies of four small hydropower plants located in the Huambo Province, located at the head of the Keve, Cunene and Catumbela Rivers watersheds.

The four plants have capacities ranging from 0,5 to 2,7 MW and are: Ucuma (2700 kW); E Cunha (25 kW); Ilha dos Amores (18000 kW); Cuima (500 kW).

The studies consisted of the assessment of the available water resources and the feasibility studies, including the definition of the diversion weirs, water conveyance systems and hydropower plants, energy transportation lines and other ancillary structures.

A preliminary cost estimation and assessment of the electric energy requirements of the surrounding areas was carried out for each plant.

Three plants which best conditions were selected for in-depth studies.



HUAMBO - ANGOLA



HYDROELECTRIC DEVELOPMENT MAJOR WORKS

PORTUGAL

Fraga (6.390 kW) and Póvoa de Cervães (6.550 kW) Hydroelectric Projects on the Mondego River. Preliminary study. (ENGIL, SGPS).

S. João do Monte (5.400 kW) and Girabolhos (6.750 kW) Hydroelectric Projects on the Mondego River. Preliminary study. (ENERPRO, LDA).

Alvor Hydropower Plant (580 kW). Rehabilitation and Refurbishment Design. Final Design and Technical Assistance. (ARBA – Associação de Regantes e Beneficiários do Alvor).

Refurbishment and Automation of the **Maranhão (7,5 MVA), Montargil (4 MVA) and Gameiro (1.640 kW). Hydropower Plants.** Preliminary Study and Tender Design. (Associação de Regantes e Beneficiários do Vale do Sorraia).

Tangil Small Hydropower Plant (3.100 kVA). Feasibility Study. (EFIEFE).

Riba de Mouro Hydropower Plant (3.850 kVA). Feasibility Study. (ENERSIS, SA).

Azibo Small Hydropower Plant (1.400 kW) included in the Macedo de Caveiros Irrigation Perimeter. Feasibility Study and Preliminary Study. (DGHERA – Dir. Geral Hidráulica, Engenharia Rural e Ambiente)

Ribeiradio Small Hydropower Plant (10.000 kW). Preliminary Study. (INAG-Instituto da Água).

Sabugal Hydropower Plant (9,5 MW) integrated in the Cova da Beira Hydroagricultural Development. Tender Design. (INAG e IDRHa – Instituto de Desenvolvimento Rural, Hidráulica e Ambiente). **1**

Serra da Estrela Hydroelectric Project. Modernisation and Automation Study of the **Desterro II Hydropower Plant (9.000 kVA).** Preliminary Study. (EDP).

Energy Recovery Power Stations of the Cooling Water System of the Sines Thermal Power Plant (2.800 kW). Preliminary Study, Final Design and Technical Assistance. (EDP).

PORTUGAL - AZORES ISLANDS

(GROUP EDA – Electricidade dos Açores)

Além da Fazenda Hydropower Project. Maximization of Power Generation (630 kW). Feasibility Studies and Detail Design, Tender Design and Construction Drawings. **2**

Ribeira Grande Hydropower Project (2 units with an installed capacity of 568 kW each) Detailed Design, Tender Documents and Environmental Studies.

Ribeira de Água d'Alto Multipurpose Hydropower Project (185 kW). Feasibility Study, Basic Design for a Design-and-Build Tender and Environmental Studies.

S. Tomé River Hydropower Project (775 kW). Preliminary Study and Design for a Design-and-build Tender.

Ribeira do Salto Hydropower Project (1.020 kW). Preliminary Study and Design for a Design-and-build Tender.

Lagoa do Paúl Hydropower Project (1.020 kW). Feasibility Study.

Salto do Cabrito Hydropower Project (670 kW). Feasibility Study, Design for a Design-and-build Tender and Technical Assistance. **3**

Túneis Hydropower Project (1.650 kW). Refurbishment and Automation Studies and Designs. Final Design and Technical Assistance.

Four Hydroelectric Developments in the S. João, S. Tomé, Meio e Lexívias Rivers. Technical and Economical Feasibility Studies.

Povoação Hydropower Project (1050 kW+ 500 kW). Feasibility Study, Design for a Design-and-build Tender and Environmental Studies.

ANGOLA

Luachimo Hydropower Project (4 units with an installed capacity of 8,9 MW each). Economical Feasibility Studies, Detailed Design and Tender Design (ENE – Empresa Nacional de Energia); **4**

Chiumbe – Dala Hydropower Project (12,42 MW). Detailed Design and Tender Documents (ENE – Empresa Nacional de Electricidade)

M'Bridge Hydroelectric Development (6 MW). Preliminary Study, Detailed Design and Tender Documents. (ENE – Empresa Nacional de Energia).

Hydroelectric Power Plant and Water Conveyance Systems in the Kuele River (6 MW). Technical and Economical Feasibility Studies, Final Design and Tender Documents. (Ministério da Energia);

Hydroelectric Power Plant and Water Conveyance Systems in the Kuebe River (4 MW). Technical and Economical Feasibility Studies, Final Design and Tender Documents (Ministério da Energia)

Small Hydropower Plants in the Huambo Province. Cunhangamua River – Cunhangâmua Waterfalls (1 MW); Kuito River –Ilha dos Amores Waterfalls (2 MW); Hama River – Hama Waterfalls (0,5 MW). Technical Feasibility Assessment (Zagope / Andrade Gutierrez);

BRAZIL

Small Hydropower Plants on the Juruena. Small Hydropower plants: Cidezal (17 MW), Sapezal (16 MW), Parecis (16 MW), Rondon (13 MW) and Telegráfica (30 MW). Consultancy services on geological, geotechnical, hydrological and energetic components (Light, SA.);

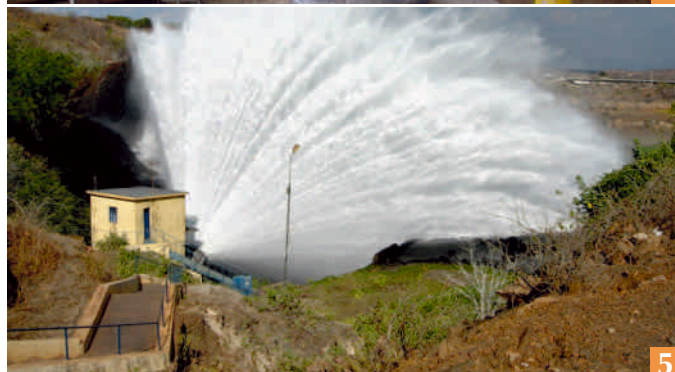
Small Hydropower Stations in the State of Ceará. Castanhão (2 x 4,87 MW) Orós (2 x 1.12 MW), Banabuiú (2 x 3.48 MW), Aracoiaba (1 x 0.42 MW), Jaburú (1 x 0.61 MW) Technical and Economic Feasibility Studies. (Secretaria Estadual dos Recursos Hídricos do Ceará). **5**

GUINEA-BISSAU

Saltinho Hydropower Project (18 MW). Design. UNDP - United Nations Development Programme.

MOZAMBIQUE

Moamba-Major Dam And Hydraulic Appurtenances Aiming At The Water Supply To Maputo. Power plant with a rated capacity of 11,5 MW. Preliminary Design (Zagope / Andrade Gutierrez / Fidens Joint-Venture).





Rabaçal River Hydropower Project close to Bouçoais-Sonim - PORTUGAL



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