Innovative power generation at Ashta I and II, Albania

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An engineering and supply contract for the major electromechanical and hydromechanical components for the Ashta I and II hydro plants in Albania. The partnership between the investor and supplier during the development process, as well as the use of innovative technology, were key features of the project strategy.

Over the last decades, the Albanian power grid has experienced long and frequent power outages caused by drought, the deterioration of the grid system which dates back to the communist era, and a failure to build new generating capacity. As a result, a large percentage of the power demand in Albania has to be covered by energy imports from neighbouring countries, such as Greece.

In response, the Albanian Government with the support of the International Finance Corporation (IFC), provided the necessary environment to attract foreign investment to the Albanian power sector. The measures included:

- a new Albanian concessions law;
- the establishment of a private public partnership (PPP) unit, and reinforcement of institutional capacity at the Ministry of Economy, Trade and Energy; and
- analysis and prioritization of a number of potential hydropower projects, and the ultimate selection of the Ashta hydro project for the implementation of a pilot PPP transaction.

The river Drin has been developed with a chain of hydro projects. The planned Ashta project will be the last in this chain and is to be located downstream of the Vau I Dejës hydro plant, about 50 km from the outflow of river Drin into the Adriatic Sea. The reservoir is fed from the Vau I Dejës scheme, with the addition of other minor inflows. Currently, most of the river flow passes the weir without being utilized, and discharges back into the Drin river, while the rest is used to feed a small irrigation system.

The Ashta project is divided into two schemes: electricity will first be generated at Ashta I, where the Spathara reservoir, with its weir and small irrigation system, were constructed three decades ago for the agricultural sector. Electricity will also be generated at Astha II, after a 5 km-long bypass channel close to the small village of Ashta, which is part of the community of Bushat. The route chosen for the channel allows for independent operation of the two plants during construction, and avoids environmental impacts on the existing infrastructure and valuable farmland.

The total capacity of the two plants amounts to more than 50 MW; annual generation is expected to be 242 GWh.

The prequalification phase for the concession began in January 2008. This resulted in 12 submissions, 10 of which met the prescribed criteria.

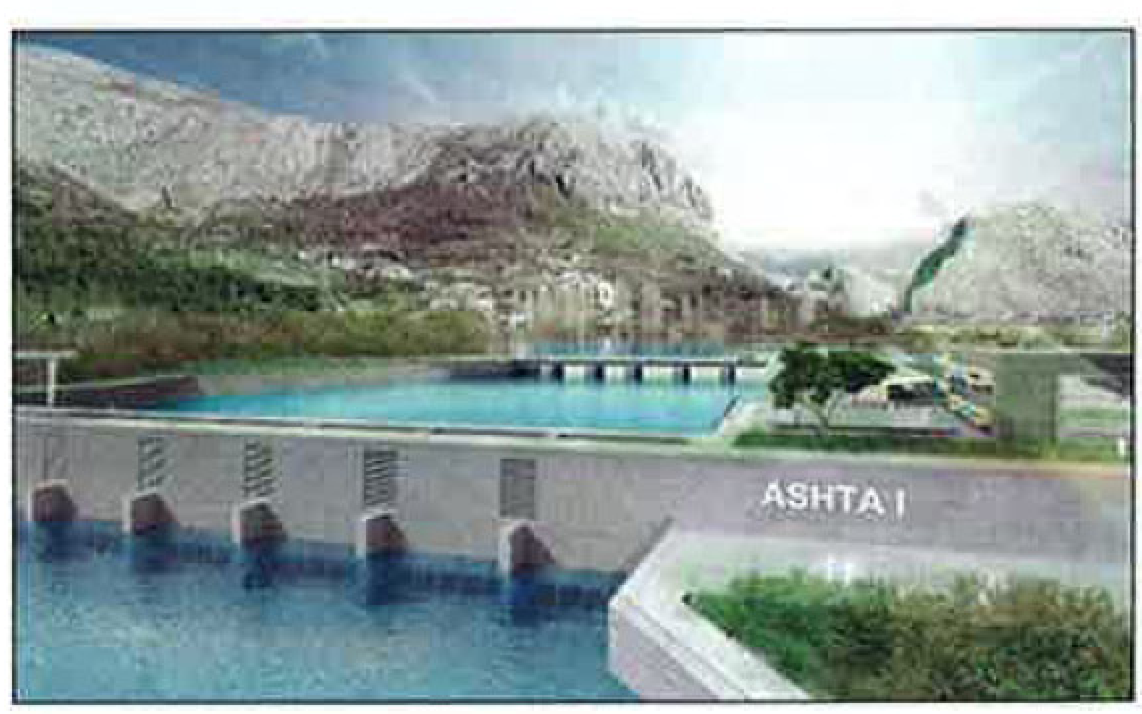
Subsequently, the Ministry of Economy, Trade and Energy (METE) issued the full tender, for outsourcing to a private investor, the design, financing, construction, ownership, operation, maintenance and transfer of a new run-of-river hydro plant with a capacity of 40 to 70 MW at Ashta, through a competitive bidding process. The project was structured on the basis of a BOOT-type concession contract between METE and the winning bidder, with a term of 35 years and an off-take agreement to be agreed with Korporata Elektronergieike Shqiptare (KESH), the Albanian power generation company.

The Ashta project area.

After a detailed assessment of the bids, in September 2008 the Government of Albania signed a concession agreement with Austria's Verbund, Austria's largest electricity utility and one of the leading hydropower groups in Europe. Project implementation will be carried out by Energji Ashta Shpk, a 50/50 joint venture between Verbund and EVN. EVN is a major regional utility in Austria, with a strong position in South-Eastern Europe.

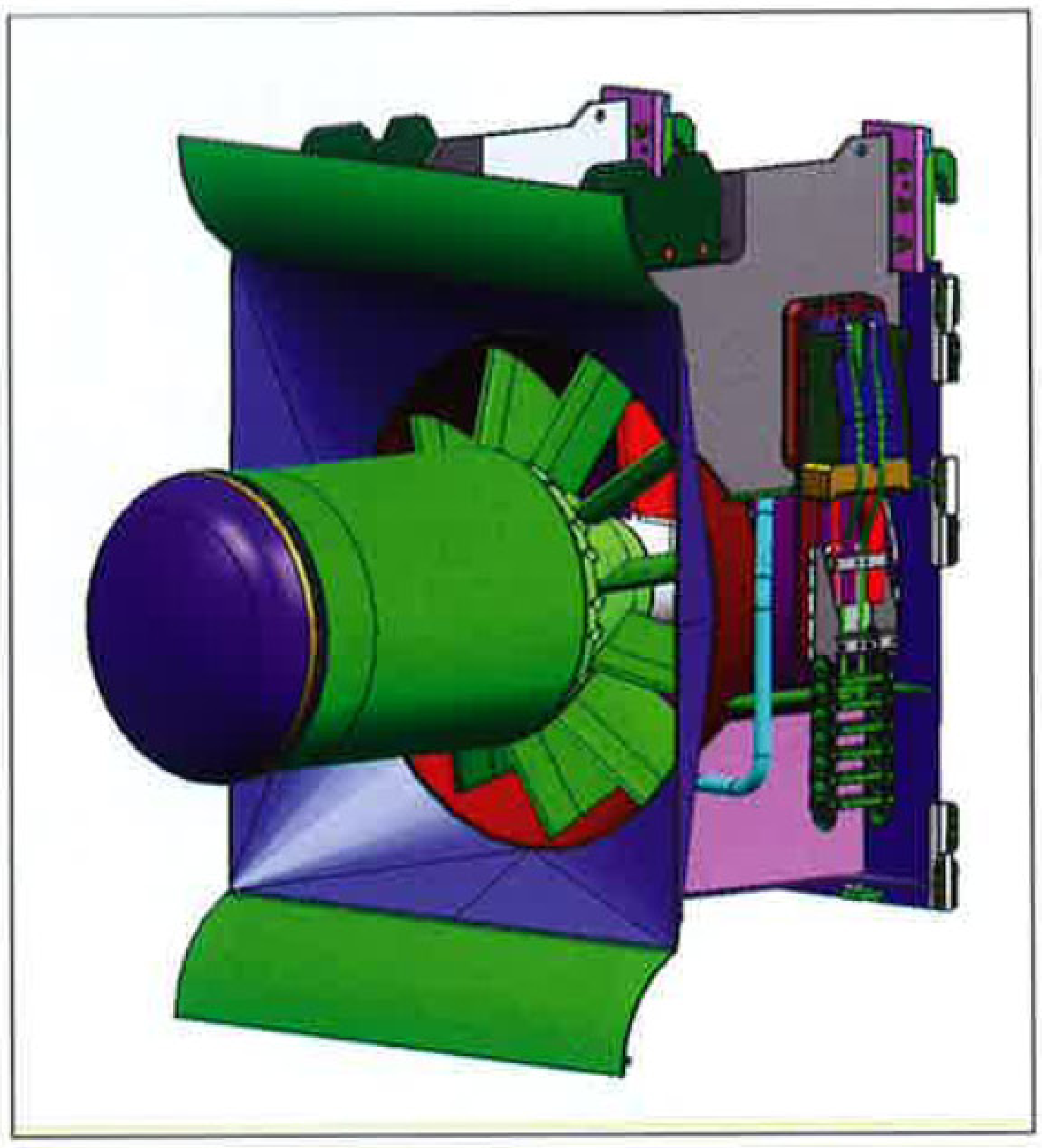
Optimal technical concept

Concepts for the development of this section of the Drin have existed since the 1990s. However, conventional hydropower technology proved not to be feasible for the project at that time.



The Ashta I powerplant concept.

A Hydromatrix module.



Therefore, the most important aspects of the development process during that period were the optimization of the economic feasibility and minimizing environmental impacts. During the bidding phase for the concession, Verbund conducted a thorough technical and economic assessment of available hydropower technologies by comparing a conventional solution, featuring bulb turbines, with a two-plant arrangement using the Hydromatrix system. Taking into consideration civil and electromechanical construction costs as well as operation and maintenance costs, Hydromatrix was identified as the best solution for Verbund, and its proposed use was specified in the concession bid.

After the award of the concession agreement, Verbund, together with Pöyry Energy and Andritz Hydro, started an intensive ten-month design phase, during which the plant concept was jointly developed and optimized in further detail.

The Hydromatrix technology

The Hydromatrix technology is based on a modular system, involving a number of small turbine-generator units (TG –units) installed in modules which form matrix-type configurations. At Hydromatrix plants, each module consists of one or more identical TG-units. The modules are interfaced by integrated or separately installed draft tubes.

One of the main advantages of Hydromatrix plants is tthat only a low tailwater depth is required, and therefore the powerhouse only requires a shallow foundation. This results in considerable savings in construction costs. The possibility to remove the TG-units during flood periods and for maintenance is another important feature, and this allowed the Ashta project to be constructed within a short time period compared with conventional run-of-river hydro plants.

Ashta I and II will be equipped with 45 Hydromatrix TG-units, each of which will be mounted at the upstream face of a concrete gravity dam. The TG-units are arranged in one row in front of the dam structure and can be individually lifted out for maintenance. The associated draft tubes are embedded in the dam structure. The electromechanical equipment is placed inside an underground gallery located above the draft tubes.

The water flow can be cutoff for each individual machine by a sliding gate on the downstream face of the dam. The gantry crane used to lifting the TG-units will be used in the future for maintenance.

A prototype runner.

Innovative generator technology

The design of the TG-units is based on the classical concept for small, compact bulb turbines, but was further developed to address the need for high reliability, low maintenance and easier grid interconnection. The TG-units for Ashta include unregulated turbines, equipped with synchronous generators with permanent magnet rotor poles (PM generator). Andritz Hydro has successfully developed and applied PM generator technology at its StrafloMatrix™ units and is now expanding the application to the Hydromatrix units.

PM generators feature stator design and manufacturing similar to classical synchronous generators (that is, coil windings; total impregnation and air cooled design). The rotor is specially designed using permanent magnets to create the rotor rotation field. The material used for the permanent magnets is NdFeB magnet material, which is glued to the rotor yoke.

Considering the large number of TG-units per powerplant, it was decided to manufacture and thoroughly test one prototype generator for both Ashta I and Ashta II before starting the production of the complete series. The prototype tests are currently in progress, with first tests showing a performance beyond the expected values.

One of the main characteristics of the PM generators is fixed excitation with constant inner voltage, E_q, defined by the geometry and shape of the permanent magnets. Once fixed, usually with the power factor on the high voltage side of the generator transformer close to 1.0, the inner voltage will stay constant in all operation regimes of the PM generators.

Specific characteristics of the PM generators

The units have low inertia (combined runner and PM rotor), $- 0.1 \div 0.4$ s, and therefore will immediately go to runaway speed during load rejection. The voltage on the generator terminals will also increase, since it is directly proportional to the speed.

Synchronous reactance is 40 to 50 per cent lower compared with classical synchronous generators, which has a positive effect on transient stability. PM generators have no transient reactance because of the absence of field windings.

On the other hand, PM generators are not foreseen for isolated operation, and the synchronization of PM generators can only be achieved with equalizing frequency and voltage angle.

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