"HYDROMATRIX® – New Operation Experiences and Development Opportunities "

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1 Synopsis

The first part of this paper provides an update of the operational experiences made at two of ANDRITZ HYDRO´s newest reference plants for HYDROMATRIX® (HM) technology: Lower St. Anthony Falls in the United States and Ashta I in Albania. Apart of giving particulars about the performance of the plants, the paper addresses some of the operational challenges.

The second part of the paper gives an update on ANDRITZ HYDRO´s project development efforts in Indonesia in cooperation with PusAir, private developers and state-controlled dam operators and construction companies. Based on actual projects in Java and South Sumatra, the paper outlines the main development steps and most important aspects of developing hydropower at existing dam structures. It also discusses the investment challenges and opportunities of low head hydropower at existing dams.

2 Introduction

During the 15 years of developing and furthering the HM technology, ANDRITZ HYDRO (AH) has been involved in a variety of different projects, which all had the common goal of finding a technically suitable and economically feasible solution for harnessing hydropower at low head sites.

The HM concept consists of a factory assembled "grid" of modules containing small propeller turbine-generator units, which can be grouped flexibly in various power plant arrangements. HM plants can be installed at existing dams and gate structures as well as used in greenfield projects.
HM modules are shipped in pre-assembled condition to the power plant site where they are installed into the existing water passage (see picture 1). The turbine-generator (TG) units are switched on and off using hydraulically operated sliding gates. The design of the modules allows the lifting or removal from its operating position like a sliding gate. This enables the passage of flood water and simplifies inspection and maintenance work on the TG-units (see picture 2).

Picture 1: 5 x 1 Unit Module of Chievo Dam, HM plant

Picture 2: TG-units of Jebel Aulia Dam HM Plant in raised position

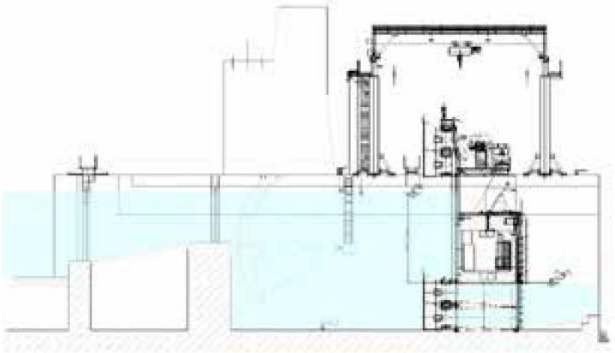
Projects that are not economically feasible with conventional plant designs can now be profitably developed by using this innovative approach. Six reference installations, each using the concept under different site-specific conditions, have now been operating successfully for more than 10 years.

2.1 Example 1: Lower St. Anthony Falls, USA

2.1.1 Plant Concept and Layout

Lower St. Anthony Falls (LSAF) Lock and Dam is located on the Mississippi River in the city of Minneapolis, Minnesota. LSAF forms part of the inland waterway navigation system and was built by the government in the 1950s. Beside a dam section equipped with radial gates and a non-overflow dam, it consists of a main lock and an uncompleted auxiliary lock. The auxiliary lock was primarily used for flood discharge before a private development group decided to convert the lock into a hydropower plant.

Picture 3: Auxiliary lock prior to plant construction



Picture 4: Sectional view of lock showing hydropower plant arrangement

The core elements of the 10 MW StrafloMatrix™ plant are

- A newly constructed retaining wall inside the existing auxiliary lock structure
- 8 modules, each containing one pair of TG-units in a two row configuration, which are placed in front of the retaining wall
- A new facility gantry crane, which allows lifting the modules during flooding (to allow flood discharge through the draft tubes) and manipulation of the electromechancial equipment located at the lock.

The draft tubes form an integral part of the retaining wall. Above the draft tubes an underground equipment gallery is situated. It contains the generator switchgear and hydraulic power units for operation of the draft tube gates. Pneumatically operated spillway gates are installed on top of the retaining wall and used to spill small ice and debris as well as for flood discharge.

Steel platforms are mounted across the top level of the auxiliary lock to allow installation of cable reels. When the TG-units are lifted out of the water by a newly installed overhead travelling gantry crane during maintenance or in the event of flooding, the power and control cables are automatically reeled up onto the cable reels.
The electrical power is transmitted from the generator switchgear located inside the underground gallery via medium voltage cables across the runway support structure of the crane, to the main transformer and a 13.8 kV outdoor switchyard located on the right embankment on the upstream side of the dam.

Picture 5: Auxiliary lock during plant construction

Picture 6: Plant seen from downstream side

Site construction started in spring of 2009. The plant started commercial operation in November of 2011.

Technical Data – Lower St. Anthony Falls StrafloMatrix™ Plant	
Plant capacity:	10 MW
Head:	7.6 m
Unit Output:	625 kW
Number of units:	16 (2 rows of 8)
Average yearly energy production:	62 GWh

2.1.2 Operational Experiences

After commissioning a plant performance test was conducted in 2011, whose results showed that the output of the turbine-generator (TG-) units exceeded the guaranteed values. The actual inflow conditions are very similar to the conditions which were simulated as part of extensive hydraulic model tests at the University of Vienna during the design and engineering phase.

During commissioning and the first months of commercial operation, water intrusion was noted into the cable junction boxes of the TG-units. After conducting a thorough analysis, ANDRITZ HYDRO decided to implement an enhanced cable system, which is phased in during the summer and fall of 2012.

In the first 6 months of operation, the plant operators had to deal with several high flow and flood events, which required lifting of all units and subsequent discharge of flood water through the auxiliary lock. One high flow event spilled a large tree trunk into the lock and against the TG-units, thereby causing minor damage on the trash rack panels of one Module. The removable panels could be easily replaced while the Module was in maintenance position.

2.2 Example 2: Ashta, Albania

2.2.1 Plant Concept and Layout

The Ashta I & II Hydropower Project is located on the Drin River near the city of Shkodra in Albania. The project was solicited by the Albanian government for a 35 year Build Operate Transfer license.

The main criteria for the assessment of hydropower technologies for the Ashta project were:

- Price per kwh
- Shallow setting to minimize excavation and avoid geological issues
- No changes in the flood planes

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