The objective of the present study was to verify experimentally the shape and magnitude of the fluid flow velocity profiles, with and without exposure to an electrical DC-potential. In addition, upscaled to field-scale, experiments in a hydroelectric power-station will also be done. The verification study system was realized as a 15.45 m slanting, 52 mm diameter pipe made of stainless steel through which tap water was flowing from one reservoir to another under constant pressure conditions. The flow velocity profile was measured by laser (Nd:YAG laser; Dantec FlowMap PIV 2000 Processor, using the Particle Image Velocimetry technique) over the cross-section of the pipe. The laser was tuned to detect the flow velocity in 38 localizations within the range 9.8 mm from the pipe wall into the water stream. The electrical DC-potential is introduced between a ring which was electrical insulated from the pipe, located at the top end of the pipe, and the pipe itself. The apparatus and procedure has been described in detail elsewhere [1-3]. In this experimental setup, the DC-potential was determined to be + 0.8 V (+0.63 V (Ag/AgCl₂)), with the positive end on the pipe. The obtained results show an increase in the velocity profile in the range near the pipewall when this electric potential was introduced (fig.1). Applied potentials below or above this particular potential showed no effect on the velocity profile. It appears that this potential causes a reduction in the head loss for the water flow.

The Norwegian hydropower industry has let us carry out some field experiments in a real hydroelectric power plant. The chosen power plant produces 12.5 MW (85 GWh), and is equipped with a single Pelton turbine. The height difference between the surface of the water reservoir and the turbine inlet is approximately 380 m. The diameter and length of the pipeline made of steel are approximately 1.0 m and 1600 m respectively. The DC-potential was applied between upper manlock, which was electrical insulated from rest of the pipeline, and the pipeline itself at the turbine inlet. The head loss was measured by the Norwegian company Norconsult as. The measured head loss before starting the experiments, was 44.1 m at maximum flow rate (4.68 m³s⁻¹). After the electrical potential application, a decrease in the head loss has been observed (fig. 2). Up to present, a reduction in the headloss of approximately 6 m (13.6% reduction) has been observed. The experiments are still in progress.

References: