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Assessment of the Bordas-Carnot Losses within the diffuser of tidal turbines using far-field and near-field CFD models.

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This project has for ambition to analyse and further the general understanding on cross-flows interactions and behaviours at the mouth of a mini/small tidal hydropower plant and a river. Although, the study of these interactions could benefit and find applications in multiple hydraulic problems, this project concentrates its focus on the influence of the transposed turbulences generated by the cross-flow into the diffuser. These eddies affect the overall performance and efficiency of the bulb-turbines by minimizing the pressure recovery. In the past, these turbulences were accounted with the implementation of the Bordas-Carnot losses coefficient for the design of tidal project using bulb-turbines. The bulb turbine technology has been the interest and subject of many scientific papers but most of them concentrate and narrow their focus on the design of the rotor, blades and combiner. This project wants to focus the design of the diffuser by performing an analysis on the development of eddies and the turbulences using computational fluid dynamic (CFD) models.

The Severn estuary is endowed with one of the highest tidal range around the hemisphere. The first part of the research requires to select case studies sites such as Briton-Ferry to virtually design mini-tidal plant in 0-Dimentional (D), 2D and 3D modelling to study development and behaviour of turbulences within the diffuser. The far-field model represents the marine environment prior and after the structure where bulb turbines are located. The near-field modelling has allowed researcher to study at much higher resolution and precision the design of a single turbine feeding model with predetermined and fix boundary condition. For this reason, a near-field model is required to study in depth the behaviour and evolution of the turbulence with the diffuser. One of the main challenge and advancement of this research is to find a methodology and system to link the far-field and near-field modelling to produce an interacting and dynamic model. The first model of the tidal plant in 0D is near completion and will provide a rough idea of the energy potential of the Briton-Ferry site based on the operation type of the turbine. Simultaneously, the 2D modelling of the area was initiated a week ago using TELEMAC-2D and Bluekenue as pre/post-processor. The hope for the conference would be to present result on the turbulence occurring at the mouth of the river and the structure in the far-field model and to have started the near-field model on Hydro3D with some idea on ways to connect it adequately to the far-field model.

Ulterior to the conference next September, the ongoing collaboration with GE will benefit the validation of the computational model as the second part of this research will consist of building a bulb turbine and the diffuser with their facilities and laboratory in Grenoble (France). Once the collection of the necessary experimental observations on the turbulence within the diffuser will be complete, the model will be refined. Finally, it will be attempt to improve the design of the diffuser.