Designing Tidal Turbine Arrays With PDE-constrained Optimisation

Simon Funke
Simula Research Laboratory
simon@simula.no

Abstract

Tidal turbine farms are an emerging technology for extracting renewable energy from highly energetic tidal sites, much like wind turbines extract energy out of the wind. To produce an economically significant amount of power, these farms consist of tens to hundreds of tidal turbines. For example, the first commercial scale tidal farm, whose deployment begins in 2016, is aimed to contain up to 398 turbines (http://www.meygen.com/). As a result, the farm designers are faced with many design variables (such as the position of each turbine), that need to be optimised in order for the farm to become economically feasible.

In this talk, we present how mathematical optimisation constrained by partial differential equations can be used to improve the design of tidal turbine farms. We formulate some important design questions as optimisation problems constrained by the time-dependent non-linear shallow water equations. Additional control constraints ensure that the design parameters remain feasible. We discuss the numerical challenges of the resulting problems, their implementation in FEniCS and dolfin-adjoint, and show optimisations of tidal farms with up to 1000 turbines.

References

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