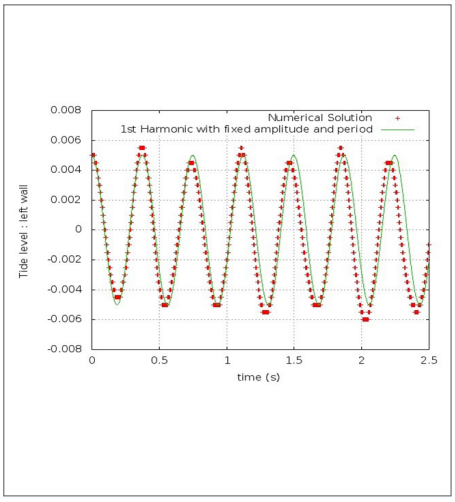
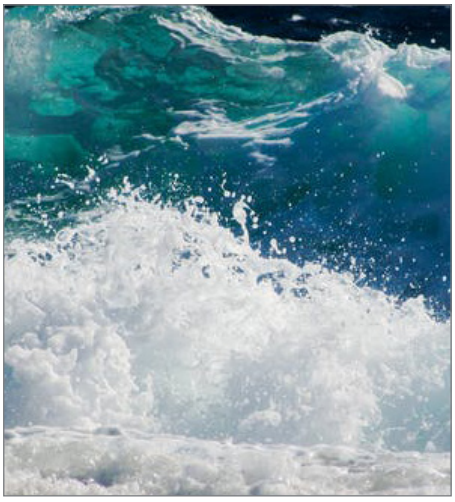
Case Study

RENUDA
FLUID SOLUTIONS

CFD tools for marine energy: University of Edinburgh

The Background





The University of Edinburgh (UoE) is a partner in the Energy Technologies Institute (ETI), a public-private partnership between global industries – BP, Caterpillar, EDF, E.ON, Rolls-Royce and Shell, and the UK Government. ETI brings together projects that accelerate the development of affordable, clean, secure technologies needed to help the UK meet its legally binding 2050 target. ETI makes targeted investments for projects in offshore wind, marine, distributed energy, buildings, energy storage and distribution, carbon capture and storage, transport and bioenergy. Those projects bridge the gap between laboratory scale research and development and commercial deployment of large-scale engineering projects.

The UK has significant marine energy resources around its coastline, and the successful commercial development of wave and tidal systems exploiting this resource could deliver a significant proportion of future UK electricity needs but, to date, these remain largely unexploited. One reason for this is insufficient knowledge of how marine energy technologies will interact with these resources on an industrial scale, and what affect that will have on the energy captured.

"This is a very tricky, challenging area to work in; Renuda is very good at it" - Professor David Ingram, Professor of CFD, Institute for Energy Systems, UoE

ETI initiated the PerAWaT project - Performance Assessment of Wave and Tidal Array Systems – to validate numerical models that quantify these effects, and thereby reduce the level of uncertainly currently present in estimates of energy capture. PerAWaT is an £8 million project that will produce tools capable of accurately estimating the energy yield of major wave and tidal stream energy, led by Garrad Hassan, and including EDF Energy, EON, the University of Edinburgh, the University of Oxford, Queen's University Belfast and the University of Manchester.

The role of UoE in PerAWaT, led by Professor David Ingram, was to evaluate and scale test the most appropriate numerical modelling tools for designing hydro turbines that would provide the most efficient conversion of wave energy. Professor Ingram's primary research interests surround the development and application of Computational Fluid Dynamics (CFD) solvers to highly transient problems involving free surfaces and other discontinuities. Currently this work is focused on water waves, specifically in cases involving violent deformation of the free surface and wave impacts on coastal structures.

The Challenge

The project team decided to use EDF's open source CFD software Code_ Saturne for testing the specific algorithms and engineering models involved in the assessment of the Tidal Energy conversion. However, this posed a problem as Code_Saturne was at the time limited to single phase flows or particulate flows and this project needed to analyse the impact of two phases, specifically water and air flows. And it needed to be capable of analysing heterogeneous multi-phase flow, not simply homogeneous.

The Solution

This proved to be a difficult project and EDF's R&D team recommended UoE approach Renuda to address this challenge.

Professor Ingram proposed to use a Level Set Algorithm as a way of resolving the interface between the two fluids. However, the algorithm as implemented was causing significant problems with the flow solver and preventing obtaining stable solutions.

Renuda investigated thee issues and found there were problems with the pressure equation. It was no longer a simple task of using user coding to change aspects of the open source software; it now needed fundamental changes to the core of the program.

Renuda's CFD software engineers already had a good working knowledge of the Code_Saturne source code, from their development work with their client EDF. They were able to make the necessary changes to implement the Level Set method in the Code_Saturne kernel and ensure that two-phase solutions of water-air problems could be obtained.

"Renuda's simulations provided evidence that mitigation will be required only periodically: this makes the project more economically viable"

This was a complex and detailed project, which involved several iterations of testing and validation.

How the UoE benefited

- UoE has now got a sophisticated software tool that they can use for future research.
- UoE were able to evaluate and test the flow solver in a stable environment.
- The project achieved a successful outcome; UoE's flow solver analyses using the open source Code_ Saturne software modified by Renuda were accepted by ETI.

"We needed to do something unusual in the CFD area. Renuda's consultant was very straight talking; he explained clearly what we could and couldn't sensibly do with CFD in this situation"

Why did UoE choose Renuda?

- Reputation – EDF has been a client of Renuda for a number of years, and confidently recommended them for this challenging project.
- Software skills – Renuda's consultants are highly skilled software specialists, who can create and adapt CFD solvers.
- Expertise – Combining expertise in CFD and software development, Renuda has a detailed knowledge of user environments and application purposes across a range of industries.

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