

# Low Flow Rate Tidal Turbines

## The Civil Engineering Application

As a form of renewable energy, tidal power has long been identified as a potential solution to the global non-renewable energy crisis. More recently, tidal turbines have emerged as cheaper and more easily implementable alternatives to traditional tidal damming and walling techniques. Turbines function through capturing the kinetic energy of tidal ebbs and flows and transforming this into electrical energy for distribution. If turbines and turbine arrays can be developed for application in zones of low volumetric flow (defined as water movement less than 2m/s), such as those adjacent to most coastlines, the scope for local power generation increases dramatically.

## Significance

It has been estimated that more than 1 terawatt of tidal energy is harvestable from areas near the coast around the world, a value equivalent to almost half of total global electricity usage. This is of particular importance as the global energy environment continues to change to reflect a movement away from damaging non-renewable sources of energy. Tidal turbines hold particular advantage due to their low environmental impact, power-predictability and particularly high relative productivity. Turbines operate out-of-sight of consumers, well-beneath shipping channels and with almost zero impact to marine life. With the advent of new technologies and methods for maintenance, particularly in geographical areas with low flow rates, tidal turbines are placed to very quickly become a cheap source of renewable electricity. And as we know, the utilization of renewable energy sources decreases national and international dependence on fossil fuels. In-turn this allows for expedited economic and social development without the destruction of the natural environment (evidenced through reductions in the release of greenhouse gases and the minimisation of site-specific forms of environmental degradation which otherwise immeasurably decrease the quality of life of people worldwide).

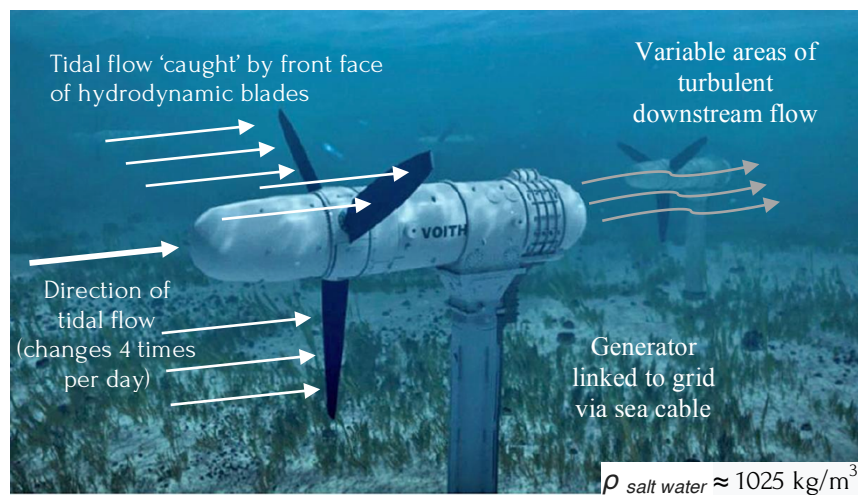


Figure 1: Array of small-bladed tidal turbines.

## Role of Fluid Mechanics

Tidal flows, as an example of the natural steady-state movement of water, are the principle input to systems of tidal energy capture. Through the intricate design of turbine blades, these flows can be 'caught' to create torque, spin a turbine and activate a generator. Operating in salt water environments, wherein the density of the fluid in question is 830 times that of air, tidal turbines are able to provide much greater scaled power than an equivalent wind turbine. Through the utilisation of turbine arrays, efficiencies can be garnered by considering the influence of wake shapes, turbulence intensities and flow alignments of upstream turbine wakes<sup>1</sup>. Here, increased velocity and surges in turbulence can create fast-moving areas of high pressure on the front face of turbines and around edges<sup>2</sup>. If effectively planned, these increased flows can be captured by adjacent turbine blades to generate even larger amounts of electricity and thereby to ensure viability to low-flow applications.

## References

- (1) Funke, S.W., Farrell, P.E. & Piggott, M.D. 2014, "Tidal turbine array optimisation using the adjoint approach", *Renewable Energy*, vol. 63, pp. 658-673.
- (2) Roc, T., Conley, D.C. & Greaves, D. 2013, "Methodology for tidal turbine representation in ocean circulation model", *Renewable Energy*, pp. 448-464.