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DTP: a Tidal Power Revolution

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Tidal power can significantly contribute to the global mix of sustainable energy resources. It is climate-independent, fully predictable, and if designed properly it is environmentally friendly and socio-economically feasible. The two traditional methods of exploiting tidal power are Tidal Barrage and Tidal Stream. This study deals with an alternative Third Method, named Dynamic Tidal Power (DTP), which contrary to the other methods, utilises the oscillating character of tides, or more precisely: the acceleration inherent to unsteady flow.

DTP uses a long dam (order of tens of km's), attached and perpendicular to a coast with shore-parallel tidal currents, to generate a local hydraulic head. This time-varying head is used to generate electricity in a more or less standard way with turbines and generators placed in (many) dam openings. For a first impression only: typical installed power for one DTP is more than 10 GW with electricity output > 2.10^{10} kWh/y and construction costs of ca. 1 EUR/W.

The physical mechanism behind the creation of the head has been described by Hulsbergen e.a., (2012). Following a heuristic approach based on analytical work done by Kolkman (unpubl.), and output from numerical tidal models, Hulsbergen (2012) concluded that the maximum head (near the coast), is: $h_{max} = 6{,}8*\pi*D*V_{max}/(g*T)$, with V_{max} the maximum alongshore flow velocity during the tidal cycle, T the tidal period and D the length of dam. Such simple relationship was also found by Mei (2012) who made a rigorous analysis of a process-based model.

After a thorough reflection on DTP, this study will first check the above formula for h_{max} , by comparing its predictions with the output from various numerical tidal models. Any differences will be analysed in the study through an evaluation of the dominant physical processes and the schematisations inherent to both the analytical and the numerical models. The study will also address the effect of the openings in the dam, as well as the shape of the dam, on h_{max}.

DTP deliberately causes a significant dynamic change in local tidal parameters. Consequently it will change large-scale flow, transport processes, waves, morphodynamics and biogeochemistry in its proximity and surroundings. Examples of morphodynamic responses are coastline re-adjustment, seafloor scouring and changes in seabed composition. This study will present an inventory of these effects, including a preliminary assessment for a hypothetical schematised case.

References:
Hulsbergen, K., e.a., 2012 Dynamic Tidal Power for Korea, 1st Asian Wave and Tidal Energy Conference (AWTECT), Nov. 2012
Mei, C.C., 2012 Note on tidal diffraction by a coastal barrier, Applied Ocean Research 36 (2012)