Flapping-wing turbines for distributed electrical generation in the Amazon River basin

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Flapping-wing turbines (FWTs) employ oscillating wings in place of a conventional rotor. Their wing motion is comprised of a pitch oscillation that is favourably coordinated with a simultaneous plunge oscillation – i.e. an oscillation transverse to the flow direction. This motion pattern sweeps a rectangular cross-section that is well-suited to use in shallow rivers and streams (Kinsey & Dumas 2008), thereby warranting further investigation for its potential to electrify remote communities located near small tributaries in the Amazon region. Furthermore, recent analysis suggests that the vast hydropotential of the Amazon River basin would be most economically exploited using low-head hydrokinetic devices like FWTs, which avoid the need for costly civil works (Chaudhari *et al.* 2021).

The present talk will review the fluid-dynamic research on FWT devices, which shows that competitive efficiencies can be attained, compared to other turbine types, if the turbine geometry and kinematics are well tuned. Design guidelines from the established literature will be summarized. Opportunities for further optimization within the high-dimensional kinematic parameter space will be discussed. The talk will also cover challenges in the hydrodynamic modelling of these devices, highlighting the knowledge gaps that must be addressed to facilitate optimization, to permit expedient and robust operational control, and to better predict FWT behaviour in the face of flow disturbances and ground effect. Other practical barriers to implementation, such as power take-off and self-starting, will be discussed.

References:

Chaudhari, S., Brown, E., Quispe-Abad, R., Moran, E., Müller, N., & Pokhrel, Y. (2021). In-stream turbines for rethinking hydropower development in the Amazon basin. *Nature sustainability*, *4*(8), 680-687.

Kinsey, T., & Dumas, G. (2008). Parametric study of an oscillating airfoil in a power-extraction regime. AIAA journal, 46(6), 1318-1330.