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PhD thesis

Development of an oscillating wind turbine

Fully funded 3yr Doctoral Position

Project description :

Wind as a worldwide exploited renewable energy source is facing societal acceptability issues due to the ever-growing scale of windfarms and their environmental imprint on natural lands. As an alternative, networks of small-scale wind (or water) energy harvesters may facilitate their installation directly in dense urban environments in order to provide electricity locally, with limited land occupation, transport infrastructure and connexion cost. However, the use of such technologies must be acceptable in heavily populated area, from both the design and disturbance points of view. The proposed project aims at developing alternative energy harvesting technologies at small scale, designed to be integrated in urban or remote environments. Such solutions fall in the Energy topic of the research theme “Sustainable Cities and Communities”, and in the “Energy, Environment, Evolution” topical UP campus.

Oscillating airfoil-based structures are seen as possible alternatives to the conventional rotating horizontal or vertical wind - or water - turbines thanks to their limited spatial extent and lower operating velocities. A two d.o.f. prototype was designed by Costa (2018) which will be experimentally investigated by the PI. Using a different approach, the “Eel energy” demonstrator (Träsch, 2018) exploits the deformation of an elongated membrane made of articulated rigid segments acting as a multi d.o.f. oscillator. The present project will focus on a continuously deformable flag-like structure with embedded devices designed to convert self-sustained oscillations (Eloy, 2008) in electricity. From the design and disturbance points of view, this concept will limit the use of moving parts and assembly in order to reduce both the structural fatigue and noise emission. One of the main challenges of the project lie in the prediction of multi-modal operating points in order to extend the operability range of the energy harvester.

The PhD will be co-supervised at Institut PPRIME (CNRS, University of Poitiers, ISAE-ENSMA) in France and at the Department of Civil Engineering and Architecture of the University of Pavia in Italy. From theoretical and numerical analysis, an experimental demonstrator will be designed and operated in the fluid-mechanics facilities of Institut PPRIME.

Short bibliography:

Costa, S., Chatellier, L., Pons, F., & Ba, M. 2018, Parametric Design of a Hydro-Elastic Energy Harvester, RENEW2018 - 3rd International Conference on Renewable Energies Offshore, 8 - 10 October, Lisbon, Portugal, 2018

Träsch, M., Déporte, A., Delacroix, S., Drevet, J.-B., Gaurier, B., Germain, G., Power estimates of an undulating membrane tidal energy converter, Ocean Engineering, Volume 148:115:124, 2018

Eloy, C., Lagrange, R., Souilliez, C., Schouveiler, L., Aeroelastic instability of cantilevered flexible plates in uniform flow. J. Fluid Mech., 611(97), 2008

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