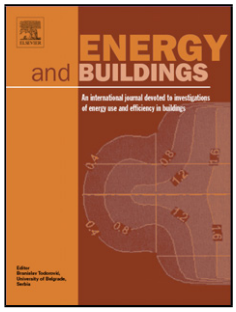

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Authors: Francesco Petrini, Konstantinos Gkoumas

PII: S0378-7788(17)32446-5
DOI: https://doi.org/10.1016/j.enbuild.2017.09.099
Reference: ENB 8020

To appear in: *ENB*

Received date: 20-7-2017
Revised date: 18-9-2017
Accepted date: 29-9-2017

Please cite this article as: Francesco Petrini, Konstantinos Gkoumas, Piezoelectric energy harvesting from vortex shedding and galloping induced vibrations inside HVAC ducts, Energy and Buildings https://doi.org/10.1016/j.enbuild.2017.09.099

Piezoelectric energy harvesting from vortex shedding and galloping induced vibrations inside HVAC ducts

Francesco Petrini*, Konstantinos Gkoumas

Sapienza University of Rome, School of Engineering, Department of Structural and Geotechnical Engineering, Via Eudossiana 18 - 00184 Rome (ITALY)

*Corresponding author (Francesco Petrini) tel. +39-06-44585072 e-mail: francesco.petrini@uniroma1.it

Abstract.

This study focuses on the conceptual development, analytical modeling and experimental wind tunnel testing of a high efficiency energy harvesting (EH) device, based on piezoelectric materials, with an application for the sustainability of smart buildings. The device, harvests the airflow inside Heating, Ventilation and Air Conditioning (HVAC) systems, using a piezoelectric component and an appropriate customizable aerodynamic appendix ("fin") that takes advantage of specific airflow phenomena (vortex shedding and galloping), and can be implemented for optimizing the energy consumption inside buildings. Different relevant aspects are explored in wind tunnel testing, after a thoughtful investigation using analytical methods. Two different configurations for the fin (circular and T-section) are compared. Aspects of the electrical modelling for the EH circuit are provided (including issues on the EH induced damping), and the effective energy harvesting potential of the working prototype device in close-to-real conditions is assessed.

1. Introduction

Energy harvesting (EH), i.e. the process of extracting energy from the environment or from a surrounding system and converting it to usable electrical energy, is a research topic with many promising applications nowadays. Its areas of application currently focus to the powering of small autonomous wireless sensors (thus eliminating the need for wires), in structural health monitoring and building automation applications. On top of that, the idea of "Smart Building" has evolved and is nowadays closer to reality. Its application requires buildings equipped with additional subsystems for managing and controlling energy sources and house appliances, and minimize energy consumption, often using wireless communication technology.