

Research Topic 17 for the ParisTech/CSC PhD Program

FOR APPLICATION, PLEASE CONTACT ADVISOR(S) BY EMAIL WITH COPY TO:

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Subfield: Applied Physics, Physics of building, Energy

ParisTech School: ENSAM (Cluny Campus)

Title: Renovation applied to building with health and energy efficiency objectives in a context of constrained economic capacities.

Advisor(s):

ENSAM Cluny: Jean-philippe Costes, jean-philippe.costes@ensam.eu

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Short description of possible research topics for a PhD:

In most of developed countries, the building sector is the largest energy-consuming sector, accounting for over 33% of final energy consumption globally and an equally important source of carbon dioxide (CO₂) emissions. If no action is taken to improve energy efficiency in the buildings sector, energy demand is expected to rise by 50%¹ by 2050. At the same time, more and more people are concerned with energy insecurity. This project aims to propose renovation scenarios of residential buildings with respect to energy saving as well as user comfort achievement. The main objective of this work is to evaluate the gains of interventions on the end use energy consumption and zone air temperatures by the means of thermal dynamic simulations. The comfort definition will be investigated and discussed: a minimum acceptable comfort in terms of healthiness could be reachable with low intervention instead of the normalized comfort that involves strong and expansive refurbishing operations. The feasibility and interest of renovation will be examined taking account the economic cost for the end user. The first step of this thesis will consist in the election and virtual design of a representative building with poor energy efficiency involving representative materials and systems. In a second step, various scenarios of renovation (including systems, the uses and function of life spaces) will be observed. The thermal heat balance and behavior of the building will be simulated using open sources tools such as EnergyPlus² and OpenStudio. At the end, relevant and robust renovation propositions including economic and feasibility objectives will be carried out.

Required background of the student:

Physics (thermal), Physics of transfer, Energy, Civil engineering, Economy

A list of 5 (max.) representative publications of the group:

Costes J.P., Evrard A., Biot B., Keutgen G., Daras A., Dubois S., Lebeau F., Courard L. Thermal Conductivity of Straw Bales: Full Size Measurements Considering the Direction of the Heat Flow, *Buildings*, 2017, 7(1), 11; doi:10.3390/buildings7010011

Obyn S., Van Moeseke G. Comparison and discussion of heating systems for single-family homes in the framework of a renovation. In: *Energy Conversion and Management*, Vol. 88, no. 1, p. 153–167 (December 2014).

doi:10.1016/j.enconman.2014.08.010. <http://hdl.handle.net/2078.1/150602>

Georges L., Massart C., Van Moeseke G., De Herde A. Environmental and economic performance of heating systems for energy-efficient dwellings: Case of passive and low-energy single-family houses, *Energy Policy*, Volume 40, January 2012, Pages 452-464 2012, doi.org/10.1016/j.enpol.2011.10.037

Decker S. A., Ndiaye A., Sempey A., Galimard P., Pauly M., Lagiere P., Bos F. Modelling and simulation to design multi-storey timber building using multi-objective Particle Swarm Optimisation. *2nd International Workshop on Simulation for Energy, Sustainable Development and Environment, SESDE 2014*.

¹ International Energy Agency, "Http://www.iea.org," 2013.

https://www.iea.org/media/training/presentations/etw2014/publications/Sustainable_Buildings_2013.pdf.

² EnergyPlus is an open-source software funded by the U.S. Department of Energy's (DOE) Building Technologies Office (BTO).