



PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 37th cycle

**THEMATIC Research Field: LOW-CAPACITY VAPOUR COMPRESSION HEAT PUMP
INTEGRATED WITH PHASE CHANGE MATERIAL HEAT STORAGE**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

Motivation and objectives of the research in this field

The decarbonization of residential sector is one of the targets of the European community for 2030. Considering new and refurbished buildings, there is a clear tendency in improving the performance of the building envelope to reduce the building heating loads. However, the energy needs for domestic hot water production are almost constant, tending to become the most predominant consumption. In this scenario, heat pumps will play a significant role since they can meet the end-user energy needs making use of potentially low or zero carbon electricity and with no local pollutants' emissions. However, differently from fuel driven boilers, heat pumps cannot supply tap hot water instantaneously and, therefore, they should be integrated with a heat storage. In this context, the objectives of the research activity are:

1. The development of a low-capacity vapour compression heat pump that could be used in new or refurbished buildings for space heating and domestic hot water production.
2. The development of a phase change material heat storage to be integrated in the heat pump system. The most suitable material and geometrical shape of the heat storage have to be identified.
3. The development of the optimal control strategy of the heat pump + phase change material heat storage



	system depending on system operating conditions and end-user request. The final heat pump should be a high efficiency heating system alternative to well-established technology such as condensing boilers and thermal storages based on hot water tanks.
Methods and techniques that will be developed and used to carry out the research	The research project involves both experimental and numerical methods and consists of three parts. In the first part of the project, mathematical models of the heat pump and of the PCM heat storage will be developed to identify the most promising configurations to be experimentally tested. In the second part of the project, prototypes of the heat pump and of the PCM heat storage will be built starting from the results of the numerical analysis. Experimental campaigns on the two systems both in stand-alone configuration and integrated together will be carried out. In the third part of the project, a refinement of the mathematical model based on the abovementioned experimental campaign will be likely carried out. A final configuration of the integrated heat pump system will be first identified through numerical analysis and then built and tested. The control strategy of the system will be developed. An energy, economic and environmental comparison with conventional systems will finally complete the analysis. Funding company: Ariston Thermo Location: Agrate Brianza (MB) and Milano (MI)
Educational objectives	To deep knowledge in thermodynamics and heat transfer processes applied to vapour compression systems and PCM heat storages. To perform a 3E (energy, economic and environmental) analysis of complex heating systems.
Job opportunities	Job opportunities in the R&D area of national and international companies that produce chiller and heat pumps. Private and public research centres.
Composition of the research group	2 Full Professors 4 Associated Professors 7 Assistant Professors 6 PhD Students
Name of the research directors	Luca Molinaroli, Tommaso Toppi



Contacts

luca.molinaroli@polimi.it
tommaso.toppi@polimi.it

www.hvac.polimi.it
www.relab.polimi.it

Additional support - Financial aid per PhD student per year (gross amount)

Housing - Foreign Students

--

**Housing - Out-of-town residents
(more than 80Km out of Milano)**

--

Scholarship Increase for a period abroad

Amount monthly

564.01 €

By number of months

6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Educational activities:

Financial aid per PhD student is available for purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences, instrumentations and computer, etc. The amount is about Euro 3.000,00.

Teaching assistantship:

Availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

Computer availability: individual use.

Desk availability: individual use.

Awards:

Awards will be recognized to the PhD candidate up to Euro 1.500,00 (gross amount, after completion of the 3rd year). More details about this program will be provided by PhD Program Steering Committee.