



**POLITECNICO**  
**MILANO 1863**

ABC<sup>PhD</sup> DOCTORAL PROGRAM  
IN ARCHITECTURE, BUILT ENVIRONMENT  
AND CONSTRUCTION ENGINEERING

## **ABCPhD CALL4SCHOLARSHIP 33**

**Research topic: Integrated technical solutions for Nearly Zero Energy Buildings based on heat pumps and photovoltaic-thermal collectors.**  
**(33 - Annex 2)**

# ABC PhD Programme – CALL 4 SCHOLARSHIPS 33

Research Topic: *Integrated technical solutions for Nearly Zero Energy Buildings based on heat pumps and photovoltaic-thermal collectors*



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## Funding and management of the thematic scholarships

- **Number of scholarships:** 1 (one)
- **Monthly net income:** € 1.007,00 (max 36 months)  
[In case of a change of the welfare rates during the three-year period, the amount could be slightly modified]
- **Additional support:** Funding for educational activities<sup>(\*)</sup> : € 1.370 per student [for the 2<sup>nd</sup> and 3<sup>rd</sup> year]
- **Starting of PhD activity:** 1/02/2018
- **Deadline for application to the call:** 04/12/2017
- **Research Director:** Niccolò Aste
- **Research Group:** Niccolò Aste, Claudio Del Pero
- **Funding and cooperating Institutions:** the scholarship is co-funded by **Politecnico di Milano, Department ABC** and **Hidros SpA**

(\*) (purchase of study books and material, funding for participation in courses, summer schools, workshops, conferences )

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## **Context of the research activity**

Ambitious goals have been set for the energy efficiency of new buildings, which have to comply with the Nearly Zero Energy Building (NZEB) standard by the end of 2020; in particular, a considerable fraction of the total energy demand of the buildings has to be covered using on-site renewable energies.

In this context, the photovoltaic technology plays a key role in the development of distributed energy generation, with particular reference to potential applications in the construction sector, in climatic contexts such as the Italian one, where solar energy and low-enthalpy thermal energy are currently the only renewable resources available in sufficient quantity to cover on a large-scale energy needs of buildings.

To this end, the proposed research is aimed at developing integrated technical solutions designed to cover the HVAC needs from solar energy, focusing on an innovative hybrid photo-voltaic-thermal solar collector (PVT) and an hybrid heat pump; the PVT component, specifically designed for building integration and capable of generating simultaneously electricity and thermal energy, is therefore coupled with a high-exergy system based on an electric heat pump, a thermal storage and an adaptive-predictive management and control logic able to ensure the maximum actual benefits.

In particular, the system allows to increase the electrical and thermal efficiency of PVT collectors, reducing the cost of electricity generated, maximizing the seasonal Coefficient of Performance (COP) of the heat pump and reducing the electricity exchange with the grid, while ensuring a high level of architectural integration.

The proposed technical solutions thus represent a practical response to the need to enable a growing expansion of renewable energies, addressing the possibility for the building sector to meet the NZEB standard

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## **Motivation and objectives of the research**

The objective of this PhD position is to deepen the knowledge in the field of solar assisted heat pumps with particular reference to the synergistic coupling of the PVT technology and vapour-compression electric heat pump systems.

The PhD Candidate will investigate different aspects in this field, such as:

- assessment on existing solar assisted heat pumps, including their application and market diffusion, limitations, etc.;
- proposal of novel technical configurations, specifically taking into account the limitations of retrofit operations;
- energy and economic assessment of the novel configurations, by means of dynamic energy simulations.

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## **Educational objectives**

At the end of the Doctoral Programme, the PhD Candidate will have a deep knowledge of all the technologies involved in the research (e.g. high-efficiency heat pumps, PVT components, BACS etc.).

The Candidate will also develop skills on building physics and energy modelling, with a specific focus on the retrofit of existing buildings.

Besides acquiring skills in the field of research development and management, it is expected that the candidate will develop a publication record in recognized international journals and conferences.

## **Methods and techniques that will be used to carry out the research**

Advanced simulation tools such as TRNSYS and EnergyPlus will be used, also analysing case studies, in order to prove the reliability and the applicability of the proposed technical solutions.

The direct interaction with manufacturers of HVAC components, PV modules and solar thermal collectors will also be encouraged during the whole research period.

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## **Skills of the candidate**

At the end of the research project the candidate will have acquired skills and expertise to operate in the fields of building physics and energy modelling, with a specific focus on the retrofit of existing buildings.

## **Job opportunities**

This research proposal offers to PhD candidates a broad knowledge in the field of advanced HVAC technologies, NZEB and solar components, that can be used afterwards in academia or the professional market. In detail, the skills will be connected to the real construction market. Furthermore, a wide range of possibilities is connected with the industrial sector, considering the manufacturing of all the components involved in the research.