



# PhD in ARCHITETTURA, INGEGNERIA DELLE COSTRUZIONI E AMBIENTE COSTRUITO / ARCHITECTURE, BUILT ENVIRONMENT AND CONSTRUCTION ENGINEERING - 41st cycle

**INTERDISCIPLINARY Research Field: DATA-DRIVEN DECISION METHOD FOR ENERGY EFFICIENCY AND ENVIRONMENTAL QUALITY OPTIMIZATION IN SCHOOL BUILDINGS**

Monthly net income of PhDscholarship (max 36 months)
<b>€ 1400.0</b>
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
<p><b>Motivation and objectives of the research in this field</b></p>	<p>Interdisciplinary PhD Grant</p> <p>The PhD research will be carried out in collaboration with research groups of the PhD programme in <b>"MATHEMATICAL MODELS AND METHODS IN ENGINEERING"</b>.</p> <p>The research aims to develop a data analysis methodology based on "statistical learning" and "Machine Learning" (ML) techniques for reducing energy consumption and increasing the indoor environmental quality in school buildings including universities. In detail, the research intends to develop a robust and scalable methodology that integrates field-measured data (indoor and outdoor), statistical models, ML algorithms in a digital tools to predict and optimize energy uses, indoor comfort and building maintenance. The research methodology involves four different phases: i) identification of advanced mathematical techniques and models for the interpretation, analysis and management of large datasets; ii) implementation of digital building models that integrates real-time measured data; iii) implementation of a multi-parameter sensor network capable of analyzing both energy flows and the indoor condition perceived by the user; iv) design of a dedicated digital platform for data</p>



	<p>collection, interpretation and management of the collected and elaborated data.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The research activity will be developed around three main activities:</p> <p>Activity 1 - Theoretical basis of large data sets analysis and methods for indoor data collection and fault detection. During this phase the student will review the scientific literature regarding digital building modelling, statistical models and unsupervised ML algorithms for data analysis and interpretation.</p> <p>Activity 2 - Data collection and data management platform development. This phase will deal with case studies selection, monitoring system development, set up and digital repository development. The student will structure a specific database for real-time data collection making links with the digital model. The activity consist also in the application of algorithms for digital model calibration.</p> <p>Activity 3 – Data evaluation and results exploitation. The validated models will be integrated into a digital platform, working as a decision making tool for supporting technicians/building owners in energy management and maintenance actions. The results will be in form of guidelines in order to facilitate the implementation of the approach in other building contexts. These guidelines will provide practical instructions for data gathering, data interpretation, maintenance prediction and in general for scaling up the digitization of the public built environment.</p>
<p><b>Educational objectives</b></p>	<p>The thesis will provide an original and comprehensive study on the energy-efficient management process of existing educational buildings. The study will contribute in developing a new concept and tool for supporting public authorities in maintaining efficient and safe the built environment. The specific learning objectives of the program allow the student to:</p> <ul style="list-style-type: none"> <li>•Develop high level knowledge in their area of specialization;</li> <li>•Master the analytical and methodological skills required</li> </ul>



	<p>to conduct research in their area of specialization and related areas;</p> <ul style="list-style-type: none"> <li>•Design and conduct original research in the specific area of research;</li> <li>•Demonstrate the ability to communicate the results of their research in a clear and effective manner</li> <li>•Demonstrate an ability to work effectively in team with other people from various, educational, and work experience backgrounds.</li> </ul>
<b>Job opportunities</b>	<p>PhD in this research area will be very competitive at both national and international level working as:</p> <ul style="list-style-type: none"> <li>•Researcher in academic institutions as well as in research centers;</li> <li>•Engineer in the research and development departments of SMEs, public institutions or large companies.</li> <li>•Create a business around their own innovations.</li> </ul>
<b>Composition of the research group</b>	<p>3 Full Professors 1 Associated Professors 0 Assistant Professors 4 PhD Students</p>
<b>Name of the research directors</b>	<p>Graziano Salvalai, Manuela Grecchi, Monica Conti</p>

<b>Contacts</b>	
<p><i>graziano.salvalai@polimi.it</i></p>	

<b>Additional support - Financial aid per PhD student per year (gross amount)</b>	
<b>Housing - Foreign Students</b>	--
<b>Housing - Out-of-town residents</b>	--

<b>Scholarship Increase for a period abroad</b>	
<b>Amount monthly</b>	700.0 €
<b>By number of months</b>	6

<b>Stage and period abroad</b>
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Institution or company where the candidate will spend the period abroad (name and brief description)	
By number of months abroad	0

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

**Additional support:**

**Budget for the research activity (only for positions supported by scholarship):** total amount Euro 5.707,20 per student.

In detail:

- 1<sup>st</sup> year Euro 1.902,40
- 2<sup>nd</sup> year Euro 1.902,40
- 3<sup>rd</sup> year Euro 1.902,40.

**Additional information about the organization and regulations of ABC-PhD programme can be found in the Regulations for the 41<sup>st</sup> Cycle of ABC-PhD:** download is available at link: <https://www.dottorato.polimi.it/en/phd-programmes>

**Additional information about ABC department and ABC-PhD programme:** available at link: <https://www.dabc.polimi.it/>

**Desk availability:** The ABC department provides non-permanent desks to be temporarily booked in common PhD rooms.