



PhD in SCIENCE, TECHNOLOGY AND POLICY FOR SUSTAINABLE CHANGE - 39th cycle

PNRR 117 Research Field: MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE FOR BUILDING DESIGN AND MANAGEMENT

Monthly net income of Phdscholarship (max 36 months)
€ 1500.0

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

Context of the research activity
<p>Motivation and objectives of the research in this field</p> <p>Construction represents one of the most important markets in the world economy; two issues make it unsustainable and inefficient: it is highly energy demanding and far from digitalization. The building sector accounts for up to 40% of global energy consumption and 36% of greenhouse gas emissions. Most of the pollution associated with buildings comes from heating, ventilation and air conditioning HVAC, lighting and other electrical systems. Both energy consumption and pollution levels are highly related to non-optimized management of building, which may also lead to discomfort for occupants. To cope with these issues, users often enact inappropriate behaviours that result in further increase of energy consumption. Most often, too, both buildings and users have specific peculiarities and needs that call for personalized solutions. To work on these challenging topics, we aim at taking a data-driven approach, instrumenting buildings and their sub-systems in order to gather data and information on their consumption profiles. Further, such instrumentation, possibly coupled with dedicated human-machine interfaces, will permit us to capture individual users' interaction with appliances and energy-related systems. By properly processing such data, the research will aim at developing novel tools based on machine learning ML and artificial intelligence AI inference methods to actively monitor the energy-footprint of the buildings, and to allow understanding how it can be decoupled into features that are only building related and</p>



	<p>features that depend on the users. By doing so, such tools could foster the transition towards an interactive environment-building-human ecosystem, in which users can interface with building while also allowing personalization of the building's characteristics. The application of ML techniques and advanced AI tools during the design and management of buildings could lead to an incisive impact on the construction sector: the incentivisation of the digital transition of the building industry. Through these advanced technologies, buildings can offer performance in accordance with the demands of their users, who become an active component of the growing human building interaction. The building itself becomes an organism that learns from its surroundings and from experience, allowing for adaptive performance improvements and ensuring pleasant spaces for occupants that are also flexible and sustainable. The application of ML algorithms to building management, therefore, could strongly contribute to the achievement and adaptation of buildings, whether existing or new, to the energy targets imposed by Italian and European standards. However, the use of AI applications calls for specific attention for the privacy of the users of such tools: in fact, up to now there is an absence of a juridical basis for collection and storage of a large amount of personal data for the purpose of setting up algorithms for operation of the monitoring tools</p>
Methods and techniques that will be developed and used to carry out the research	New model tools will be implemented within dynamic building energy simulation software, e.g. Energy Plus® developed by the Lawrence Berkeley National Laboratory together with other top U.S. research groups for the U.S. Department of Energy. Both supervised and unsupervised learning approaches will be considered, developed within a multidisciplinary team to optimize the effectiveness of context-dependent decision-making. The research will include the development of proof-of-concepts of the tools, including field installation, testing of performance and optimization. Schools, offices and residential buildings will be addressed as case studies. The research will be partially developed at the headquarters of Advanced Engineering s.r.l. in Milan, Italy.



Educational objectives	The new EPBD provides for the use of dynamic simulation tools to assess the energy performance of buildings. The research results may form the content of future advanced courses in the study of building energy behaviour.
Job opportunities	PhD graduates will be able to address the need for interdisciplinary figures capable of designing advanced BMS systems and applying them during the building management phase. They will also have the opportunity to start careers as researchers at universities and research departments.
Composition of the research group	2 Full Professors 4 Associated Professors 5 Assistant Professors 5 PhD Students
Name of the research directors	Paolo Oliaro / Mara Tanelli

Contacts

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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	750.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	ADVANCED ENGINEERING s.r.l.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	da definire



By number of months abroad	6
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Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

A desk, a personal computer and software licenses will be provided during the three-year doctoral program at Advanced Engineering s.r.l. where the research will be partially conducted. In addition, a desk and instrumentation necessary for research development, such as software for dynamic simulation of building energy behaviour, will be available at the department. Teaching assistantship opportunities will be taken into consideration during the triennium.