



PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 39th cycle

**PNRR 118 PA Research Field: DESIGN AND OPERATION OF MULTI-ENERGY DISTRICTS
IN AN URBAN ENVIRONMENT**

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

According to IEA, cities are responsible for 65% of energy consumption and 70% of GHG emissions worldwide. At the same time, they are more exposed to some risks related to the energy transition, including: weakness of energy networks, interaction between different energy-related sectors and energy poverty. Multi-Energy Systems (MES) optimally integrate different energy sectors, including electricity, transport, heating and cooling, and have recently emerged as an efficient solution to the decarbonization problem, especially in urban contexts, where they are often indicated as Multi-Energy Districts (MEDs). MEDs intend to fully exploit the potential of digital, energy storage and sector coupling solutions in order to drive cities along their energy transition path. The objective of the research is to develop modelling tools and digital solutions to optimize the design and operation of MEDs in an urban environment. This will be done working on an Energy Management Systems (EMS) able on one hand to take care of the energy and non-energy related demand of services within a MED, including both industrial and tertiary sector users; on the other hand, to interact with the urban environment, providing services to the energy and non-energy related urban networks. Models and tools developed will leverage on a set of different cross-cutting solutions, including:

- digital technologies, comprising cloud and edge-based architectures (SCADA, DCS, PLC);



	<p>architectures (SCADA, DCS, PLC);</p> <ul style="list-style-type: none"> •energy storage technologies, referring in particular to electrochemical and heat storage; •sector coupling solutions, integrating all the most important sectors of the urban environment (power, heating and cooling, mobility). <p>In particular, the research will focus on tools and architectures able to provide cutting-edge solutions based on the concepts of sharing economy and demand side management, with the objective of widening their application to all the relevant sectors within the urban environment.</p> <p>Finally, the research focuses on industrial engineering solutions where a background or an inclination towards software automation is appreciated. With a multi-disciplinary approach, these abilities, characterizing an engineering background, will be developed together with the capability of participating to the governance process of public administrations (local, regional and national), supporting strategic decisions with design tools able to effectively exploit the novel information and communication technologies available. These will be done, according to Italian DM 118/2023, to strengthen the capacity of public administrations in identifying the main problems and design the most effective policy tools to solve them, favoring the green and digital transition and contributing to the streamlining of governance models.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The research will mainly leverage on optimization models, including approaches taking care of uncertainty (stochastic optimization) and different decision levels (distributed and multi-level optimization). These models will be developed and tested within digital-based architectures, including the necessity of handling a large amount of data (big data analysis) and of coordinating on-field and on-cloud solutions. Finally, advanced techniques, based on machine learning and statistical inference, will be analysed and applied whenever needed.</p> <p>The research will be conducted in collaboration with AMAT and will focus on the municipality of Milan; the neighborhood of Città Studi, and specifically the university</p>



	campus of Politecnico di Milano, will be the main test-bed for the experimental validation of the proposed tools, that will be conducted in coordination with local system and services operators. Despite this, developed solutions will be shared and possibly applied also to other urban context worldwide, leveraging on the international network of the C40 initiative (https://www.c40.org/) in which the hosting institution is involved.
Educational objectives	The researcher at the end of his/her research program will be able to manage tools and models typical of the industrial engineering world, while taking care at the same time of all public policy aspects. These abilities will be developed with a specific reference to the digital and ecologic transition that is expected for urban contexts.
Job opportunities	The researcher will be able to work in R&D departments of public policy bodies, including Ministries and public agencies, municipalities, regulatory authorities and research centres. Also, job opportunities will be offered by system operators, especially energy-related ones (DSO, TSO), and consultancy companies at all levels.
Composition of the research group	2 Full Professors 3 Associated Professors 3 Assistant Professors 10 PhD Students
Name of the research directors	Prof. Maurizio Delfanti

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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	700.0 €
By number of months	6



National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Agenzia Mobilità Ambiente Territorio (AMAT) (https://www.amat-mi.it/) (technical structure of Milan Municipality)
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	To be defined with the candidate. Main options: RWTH Aachen (https://www.rwth-aachen.de) - INESC TEC (https://www.inesctec.pt/en)
By number of months abroad	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. This amount is equal to 10% of the annual gross amount, for 3 years.

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.