POLITECNICO DI MILANO

PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 38th cycle

INTERDISCIPLINARY Research Field: HIGH-FIDELITY CFD METHODS FOR INTEGRATION OF DISTRIBUTED ENERGY GENERATION IN URBAN ENVIRONMENT

Monthly net income of PhDscholarship (max 36 months)
€ 1350.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch, during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Interdisciplinary PhD Grant The PhD research will be carried out in collaboration with research groups of the PhD programme in "**AEROSPACE ENGINEERING**". See https://www.dottorato.polimi.it/?id=422&L=1 for further information. High electricity prices and the lowering costs of renewable technologies and energy storage are leading European energy consumers towards a distributed generation and self-consumption model. Electricity consumers are increasingly becoming prosumers (producers and consumers Furthermore, the concept of smart city as sustainable and efficient urban center providing high quality of life to its inhabitants with an optimal management of its resources, including clean and cost-effective energy generation, is a key issue. Under this setting, distributed generation can provide an adequate tool to deal with energy reliability and to successfully implement renewable sources This may be achieved by reducing energy consumption and using renewable sources of energy such as wind power. Wind power is an abundant source of renewable energy, but it is not commonly employed in urban areas, because of the existence of obstacles like buildings and other structures that convert high speed laminar flow into a low-speed

	turbulent flow with potential generation of noise. Moreover, traditional wind power turbines are not designed to work with low-speed wind (2 to 6m/s) and turbulent flows. This study attempts to provide a comprehensive computational framework to run High-Fidelity Simulations of grids of Small Wind Turbines (SWTs) operating in real urban environments (Smart Cities). Novel numerical techniques will be employed to favor fast and reliable simulations on PGA architectures on Leadership Class Machines (HPC), that will lead to the definition of the optimal installation setup of the VAWT In urban environments.
Methods and techniques that will be developed and used to carry out the research	The research aims at perform a comprehensive modeling of urban environment with distribute energy generation, with specific focus on: a) the development of modern accurate and reliable numerical methods, to overcome the common limitations in high-fidelity LES-CFD simulations of large scale problems on leadership class machines/PGA architectures; b) the application of novel mesh handling strategies deriving from the immerse boundary method combined with the modelling of ABL flows (neutral, stable and unstable). The resulting tool will model the integration of wind energy distributed generation in a realistic urban environment, characterize the outdoor livability and find the optimal distribution of installed wind generators in terms of produced power and noise. Collaborative work of the proponents has already been established since 2015 within the CFDHub interdepartmental laboratory at PoliMi.
Educational objectives	The learning outcome of the ideal candidate is organized as follows: - Year 1: improve the understanding about the sustainability of urban environments in terms of outdoor thermal comfort, limits in the pollutant distribution and distributed energy generation through small wind turbines. This aspect increases awareness and competence regarding the long-term objective of the project and application of the numerical methods and modeling approaches to be developed / improved during the PhD. - Year 2: improve and develop the knowledge and

	competences on numerical methods, subscale models for high-fidelity simulations to run on leadership class machines (HPC). Methods for the multi-scale simulation of urban environments -where small-scale wind turbines for distributed energy generation are installed - will be applied and tested. - Year 3: optimization of the installation layout for distributed energy generation from wind resources in real urban environments by high-fidelity simulations of different environmental conditions. Generated data output can be a database for e machine learning methods for the optimization of the same problem.
Job opportunities	Themo-fluid dynamic expert for Industrial and Civil companies and/or for research centers and academia
Composition of the research group	0 Full Professors 1 Associated Professors 1 Assistant Professors 6 PhD Students
Name of the research directors	Riccardo Mereu; Federico Piscaglia

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	675.0 €
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. 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.