



PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 39th cycle

**THEMATIC Research Field: AERODYNAMICS AND AEROELASTICITY OF WIND ENERGY
SYSTEMS**

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	
<p>Motivation and objectives of the research in this field</p>	<p>For years, the European Union has set the goal of climate neutrality by 2050, a target that would lead to being the first climate-neutral continent. The COP28 meeting, held in December 2023 in Dubai, confirmed the commitment to reduce global emissions by 43% by 2030 and, in addition, committed to triple renewable energy capacity by the same year. This is considered the heart of The European Green Deal [1]. In accordance with these European goals, the Italian PNRR also stipulated that a minimum of 37% of spending must support these climate goals [2]. In 2022 electricity generation from wind increased by a record 14%. However, to get on track with the Net Zero Emissions by 2050 Scenario, the average annual generation growth rate needs to increase to about 17% [3]. Although on-shore wind is a proven, mature technology with an extensive global supply chain, there is still much to be done to improve the technology and cost of upcoming off-shore wind farms. Floating off-shore horizontal axis wind turbines (FO-HAWT) in fact still have several critical aspects in the modelling and then in the simulation and design phases because of the different aspects such as unsteady aerodynamics and flexibility/aeroelasticity of the rotor blades. In parallel with these aspects, vertical-axis floating solutions (FO-VAWT) are being proposed because of their better stability behaviour under severe oscillations. But even in this case, topics related to fatigue loads and aerodynamic/aeroelastic modelling are to be further</p>



	<p>investigated. Finally, new technologies that are capable of harnessing wind energy at higher altitudes, thus placing themselves in addition to well-established land-based wind turbine technologies, are emerging as very interesting solutions to contribute to the energy mix. These Airborne Wind Energy Systems (AWESs) are still in need of modelling and simulation tools to reduce time and costs in the design phase. These technologies, although different from each other, have research aspects that bring them together, such as the development of engineering models of aerodynamics in the design stages, the development of aeroelastic models for load and stability analysis along with the need for cost of energy models and life cycle assessment. [1] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en, visited 01/2024 [2] https://www.governo.it/sites/governo.it/files/PNRR.pdf, visited 01/2024 [3] https://www.iea.org/energy-system/renewables/wind, 01/2024</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The design of a wind energy system is a very complex procedure which requires accounting for different engineering aspects, such as the aerodynamic and structural analysis, control design, aeroelastic phenomena, system integration, and, for AWES, flight mechanics and conceptual aircraft design. In the decades, the research group has developed technologies for the analysis, optimization and design of these multidisciplinary systems. This system integration topic is a complex and constantly evolving research activity that nonetheless forms the basis of this PhD project. Specifically, the PhD student will work on the development of aerodynamic engineering models for wind energy systems (FO-HAWT, FO-VAWT and AWES) to be integrated into the MDAO (Multidisciplinary Design Analysis and Optimization) tools partly already developed by the research group in which she or he will be joining. These models will be compared and validated with higher fidelity simulations (e.g. CFD) and experimental data already available in the literature and/or available to the research group. The activity will therefore be mainly</p>



	<p>numerical, but there will also be experimental tests (such as wind tunnel experiment and flight tests for AWES), some of which are already planned for the next few years within EU projects (TWEET-IE, SUDOCO and MERIDIONAL) managed by the research group. Should additional funding arrive later, the PhD student will also be able to collaborate in these new experimental projects.</p>
<p>Educational objectives</p>	<p>Concurrently with the development of research, the PhD student will be required to spend time to the acquisition of highly specialized technical and personal skills geared toward her or his future entry into the relevant market. In particular, the PhD student will be required to complete credits through attendance at Doctoral level courses provided by the Politecnico di Milano both through the various Departments and through the Doctoral School itself. The choice of the study plan will be made by mutual agreement with the Doctoral student privileging her/his specific interests and the relevance of the chosen subjects to the scientific sector of the Doctoral School. In addition to this course of study, the PhD student is offered the opportunity to take any course that is part of the Master's Degree programs at the Politecnico. In addition, any collaborations that may arise with companies in the sector will give the Candidate the opportunity to explore the industrial world, thus expanding her/his skills outside the academic world. The figure to be trained will therefore have an excellent ability to work in the field of research and development, but with a focus on the Italian and non-Italian productive/industrial world. Since a strong scientific relevance of the proposed research is expected, the PhD student will be offered the opportunity to publish contributions in peer-reviewed scientific journals and, if necessary, to present her/his results at Scientific Conferences in the field (e.g. EAWE PhD Seminar, TORQUE, WESC). If desired, the Candidate may be involved in teaching support activities. As is now the practice in many European projects, the PhD student research activities will also be publicized in dissemination activities towards the young and adult public in the various initiatives already in place at Politecnico di Milano (open day lab, MeetMeTonight, social channels, etc.).</p>



Job opportunities	<p>The research project has a strong wind energy market orientation and aims to develop methodologies that can be directly exported to the market itself. During the Ph.D., the Candidate will acquire excellent skills inherent to the wind energy sector: since the research proposes to develop methodologies that impact at the system level, and thus touch many aspects of the operational life of the plants (HAWT, VAWT and AES), the Candidate will be required to develop solid analytical skills, particularly with respect to modelling the aerodynamic and aeroelasticity (and hence hydrodynamic, structural, control and inertial phenomena acting on the wind energy system). At the same time, she/he will develop integrated design skills of the various components of the park (turbines, support structures, electrical connection, transportation). In addition, the Candidate will develop a solid understanding of the optimization techniques necessary for the development of the algorithmic part. At the end of the research, the Candidate will therefore have developed valuable multidisciplinary skills that are typically valued by the various players in the target market. Job opportunities, however, are not limited to the Italian and international wind energy sector, but also to all those industrial fields where multidisciplinary design skills and modelling and complex systems integration capabilities are required (such as aeronautics, space, automotive, etc.).</p>
Composition of the research group	<p>0 Full Professors 2 Associated Professors 1 Assistant Professors 4 PhD Students</p>
Name of the research directors	Prof. Alessandro Croce

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)	--
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Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

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

The PhD candidate will receive a desk, possibly through a hot-desking procedure, and a personal computer, if needed. Apart from the compulsory ones, the PhD candidate will have the opportunity to follow additional courses and receive economic support to attend summer schools and participate in conferences. There will be the possibility of paid teaching assistantship.