POLITECNICO DI MILANO

PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 38th cycle

Research Area n. 3 - Systems and Control

PARTENARIATO PNRR Research Field: DEVELOPMENT OF OFFSHORE AIRBORNE 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	
Motivation and objectives of the research in this field	This research project is in the framework of NEST PARTENARIATO ESTESO NETWORK 4 ENERGY SUSTAINABLE TRANSITION CUP D43C22003090001 Decreto di Concessione D.D. 1561 del 11/10/2022 Airborne Wind Energy (AWE) is attracting the attention of policy makers and stakeholders with the promise of producing large amounts of cost-competitive electricity with wide applicability worldwide. Since the pioneering experimental endeavors in the years 2000-2010, there has been a clear technology convergence trend and steady progress in the field. Today, AWE systems can operate automatically with minimal supervision in all operational phases. A first product is also being commercialized. However, several challenges need to be met to upscale and industrialize these systems. This PhD research project aims to resolve some of these issues, in particular pertaining to the offshore application of AWE, for which there are almost no studies in the literature. The aim will be to derive new system models that are suitable to describe the dynamics of deep offshore AWE systems and their interactions with the waves, and then to develop for the first time suitable automatic control laws to enable

POLITECNICO DI MILANO

	effective and optimal operation in this context, finally to evaluate the feasibility and economics of offshore AWE, also in connection with other sustainable energy solutions. This PhD studentship is in the scope of the Extended Partnership "NEST - Network 4 Energy Sustainable Transition".
Methods and techniques that will be developed and used to carry out the research	The PhD candidate will develop world-first deep offshore AWE models using a mix of model-based and learning-based approaches. The models will account for the kite, the tether, the marine platform, the wind and the sea motion and their interactions. Then, nonlinear control design techniques will be developed to enable close-loop operation of the system, and optimization-based approaches will be employed to carry out system-control co-design and to adapt in real-time the system operation to the time-varying and uncertain wind/wave conditions, aiming to optimize power extraction subject to operational constraints. The models will be partly derived from data provided by AWE companies, and possibly some of the developed control approaches will be applied to real-world AWE prototypes. In this respect, a good part of the PhD research can be allocated to the realization of a prototype to test the behavior of the floating offshore platform in a indoor testing pool. Motivated by the challenges posed by AWE systems, it is expected that the PhD candidate will also develop innovative methodologies for adaptive nonlinear control of constrained system in uncertain and time-varying environments, a field of theoretical research nowadays still very much open. The new methodologies will be based on recurrent model set identification and robust model predictive control implemented at high level, to reconfigure/tune feedback controllers at lower level, in a hierarchical and distributed structure.Finally, the developed models and control techniques will be employed to simulate single units and large-scale offshore AWE farms; these simulations, coupled with realistic wind data pertaining to specific sites in the Mediterranean and in Northern European sea locations, will deliver estimates of yearly energy generation and related energy cost, to be compared with those of existing renewable and non-renewable solutions.

POLITECNICO DI MILANO

Educational objectives	The PhD candidate is expected to gain deep knowledge of modeling and simulation of nonlinear and distributed systems mechanically coupled by distributed-parameter elements (the tether), of modeling of wind and wave behavior and their effects on wind energy systems, of flight mechanics and aerodynamics, of mechatronic system design and construction, of nonlinear, hierarchical, and distributed control design, finally on adaptive and model predictive control
Job opportunities	Upon completion of the PhD program, the candidate will have work opportunities either in companies in sectors such as AWE, aerospace, wind energy, automation and control, or at universities and research centers dealing with wind energy research and/or automation and control research.
Composition of the research group	0 Full Professors 1 Associated Professors 0 Assistant Professors 5 PhD Students
Name of the research directors	Lorenzo Mario Fagiano

Contacts
lorenzo.fagiano@polimi.it https://fagiano.faculty.polimi.it/ https://www.sas-lab.deib.polimi.it/

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
LIST OF UNIVERSITIES, COMPANIES, AGENCIES AND/OR NATIONAL OR INTERNATIONAL INSTITUTIONS THAT ARE COOPERATING IN THE RESEARCH: Politecnico di Milano;

Extended partnership "NEST - Network 4 Energy Sustainable Transition"; Politecnico di Torino; TU Delft

EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student
5.707,13 Euro

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

D.D. 341 del 15/03/2022 Avviso pubblico per la presentazione di Proposte di intervento per la creazione di "Partenariati estesi alle università, ai centri di ricerca, alle aziende per il finanziamento di progetti di ricerca di base" - nell'ambito del Piano Nazionale di Ripresa e Resilienza, Missione 4 "Istruzione e ricerca" - Componente 2 "Dalla ricerca all'impresa" - Investimento 1.3, finanziato dall'Unione europea - NextGenerationEU