POLITECNICO DI MILANO

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

Number of scholarship offered	11
Department	DIPARTIMENTO DI ENERGIA

Description of the PhD Programme

With the PhD Programme in Energy and Nuclear Science and Technology (STEN), the Department of Energy offers to graduate students a research opportunity in the following areas: production, conversion and transmission of energy, rational use of energy and environmental control, thermal science, nuclear systems and nuclear fuel cycle, radioprotection and application of ionizing radiations, methods for safety and reliability analysis and development of innovative materials for energy applications.
The PhD Programme has the objective of providing high quality training in scientific research and, as a consequence, preparing professional profiles capable of tackling the numerous activities involved in high level research, both in academia and in industry, which often requires a higher level of education than that offered by the Master of Science and Master study courses. The PhD graduate is specifically trained for leading, organizing, planning, managing and controlling research activities at high levels of international competitiveness in the field of Energy and Nuclear Science and Technology.

The department involved in the STEN PhD is the Department of Energy, which is also the administrative responsible for this PhD programme.

The research subjects offered by the STEN PhD Programme are listed in the relevant call.

POLITECNICO DI MILANO

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

THEMATIC Research Field: ADVANCE MODELLING OF BOUNDARY PLASMAS IN MAGNETIC FUSION DEVICES

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	Investigation, with suitable theoretical and numerical methods, of plasma-wall interaction and transport in linear and tokamak machines. Focus of this PhD program will be on: - numerical description of fusion relevant plasmas - interpretation of available experimental results - design and proposals of relevant experiments, with specific reference to plasma exposure of nanostructured materials and coatings with suitable composition, morphology and structure See:http://www.nanolab.polimi.it
Methods and techniques that will be developed and used to carry out the research	Development of fluid and Montecarlo descriptions, exploiting the most suitable, available and internationally recognized codes (e.g. SOLPS-ITER, GBS, ERO 2.0) to investigate: i) plasma properties in linear machines like GyM ii) the interpretation of experiments performed on tokamaks like AUG, TCV iii) the role of wall materials properties in the plasma-wall interaction.
Educational objectives	

	Education of people to be "launched" in the world of research and technology in the field of physics and engineering of materials and plasmas, able to manage interdisciplinary issues, perform and interpret complex numerical and experimental investigations and produce new equipment.
Job opportunities	Private and public R. & D. Highly qualified positions in a wide range of industries related with production, development and use of materials. Additional specific opportunities to join the national and international research programs in the field of nuclear fusion.
Composition of the research group	3 Full Professors 4 Associated Professors 2 Assistant Professors 16 PhD Students
Name of the research directors	Matteo Passoni

Contacts
Email: matteo.passoni@polimi.it Ph: +39-022399-3267 http://www.nanolab.polimi.it/Persone/Passoni-eng.htm

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
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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: BUILDING INTEGRATED RENEWABLE ENERGY SYSTEMS

Monthly net income of PhDscholarship (max 36 months)
€ 1195.0 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	The nearly Zero Energy Buildings target set by the EU directives requires coupling renewable energy sources to the building as well as reducing the energy needs by improving the building envelope efficiency. Integrating renewable energy sources into the building envelope is a challenge that would provide the maximum exploitation of the building surfaces with the minimum visual impact and, possibly, limited costs. This research will support the development and the assessment of innovative materials, products and systems for the integration into the building envelope of solar energy (PV systems), geoexchange (energy foundations), and new insulation products from recycled materials in a circular economy approach.
Methods and techniques that will be developed and used to carry out the research	Dynamic modelling of PV components integrated into the building facade and development of optimal control algorithms. Dynamic modelling of ground heat exchangers integrated into the building foundations with developmentof design methods. Experimental characterization, by means of dynamic (TPS) and static (double vented thermal chamber) methods, of the thermal performances of new insulation products from recycled materials (https://www.energia.polimi.it/dipartimento-di-energia/laboratori/laboratori-di-

	ricerca/termofisicaedificio/#c2489). Opportunity to validate the models on experimental test cases
Educational objectives	To develop specific competences in modelling daylighting, heat transfer in building envelope components, natural ventilation, PV technologies, ground heat exchangers and ground source heat pumps. To develop transversal capabilities in combining and validate models for complex systems.
Job opportunities	R&D in Building Construction, BIPV and HVAC industries. Energyconsultant in engineering for designing and renovating buildings. Managing and auditing in Energy Service Companies. Scientific Research in public and private institutions.
Composition of the research group	0 Full Professors 1 Associated Professors 1 Assistant Professors 0 PhD Students
Name of the research directors	Adriana Angelotti e Alessandro Dama

Contacts
Adriana Angelotti, Email: adriana.angelotti@polimi.it Alessandro Dama, Email: alessandro.dama@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	597.50 €
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.

POLITECNICO DI MILANO

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

THEMATIC Research Field: CARBON DIOXIDE - HYDROCARBONS BLENDS FOR MEDIUM-HIGH TEMPERATURE VAPOUR COMPRESSION HEAT PUMPS

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0 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	In the last years, due to environmental regulations, the air conditioning and refrigeration industry is facing a process of reduction of greenhouse gas emissions that forces to substitute the hydrofluorocarbons (HFCs) traditionally used with low Global Warming Potential (GWP) refrigerants. Within this framework, one of the most promising solutions appears the use of natural working fluids such as ammonia, carbon dioxide or hydrocarbons. Indeed, these refrigerants are present in nature and, therefore, are low GWP substances that do not harm the environment. However, their use poses some important challenges related to some unfavourable property: ammonia is toxic and mildly flammable, carbon dioxide generally operates with high pressures and low performance due to low critical temperature and hydrocarbon are highly flammable. The goal of the project is the study of carbon dioxide-hydrocarbons blends as low GWP working fluid for the next generation of medium-high temperature heat pumps. The new family of blends of natural substances is supposed to mitigate both the drawbacks of carbon dioxide (low critical temperature, high operating pressures, high compressor discharge temperature and low performance) and those of the hydrocarbons (mainly flammability). Overall, the project will analyse blends able

	to improve the operation of the system: 1. From the energy performance point of view, since they work in subcritical mode with higher COP. 2. From the reliability point of view, since the thermo-mechanical stress of the compressor, the heart of any vapour compression system, is lower. 3. From the operation safety point of view, since the blend is non-flammable, or, at worst, mildly flammable.
Methods and techniques that will be developed and used to carry out the research	The research project involves both experimental and numerical methods. The experimental activity will be carried out using the set-up available at HVAC Lab that will be upgraded for the research project. The modelling activity will be carried out starting from the models already available in the research group, updating and validating them based on the experimental data. The modelling tools will be finally used to draw guidelines about the use of carbon dioxide-hydrocarbons blends in some selected applications.
Educational objectives	The candidate will deepen his/her knowledge in thermodynamics and heat transfer processes applied to vapour compression systems. The candidate will gain expertise related to the experimental activities, the R&D planning and management and the modelling of components for vapour compression systems. Overall, a critical sensibility will be developed.
Job opportunities	Job opportunities in the R&D area of national and international companies that produce chiller and heat pumps. Private and public research centres.
Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 4 PhD Students
Name of the research directors	Luca Molinaroli

Contacts
luca.molinaroli@polimi.it 39-02-23993872

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

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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: CATALYSIS FOR ENERGY APPLICATIONS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	To study and develop innovative catalysts and catalytic reactors and processes for energy-related and environmental applications.
Methods and techniques that will be developed and used to carry out the research	Testing of catalysts under laboratory conditions. Kinetics analysis and study of reaction mechanism. Analysis of the role of heat and mass transfer phenomena in catalytic processes. Mathematical modelling of catalytic reactors.
Educational objectives	To gain a high-level knowledge about catalytic processes for energy applications and environmental protection.
Job opportunities	Chemical industries, refineries, developers and users of energy conversion technologies, catalyst manufacturers, car manufacturers.
Composition of the research group	6 Full Professors 4 Associated Professors 2 Assistant Professors 16 PhD Students
Name of the research directors	Tronconi,Lietti,Groppi,Beretta,Nova,Maestri

Contacts
enrico.tronconi@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

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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: CFD MODELING OF INTERNAL COMBUSTION ENGINES

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates during or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	To improve the understanding of physical and chemical processes occurring in internal combustion engines and provide computational tools which can help the designer in the development of next generation engines. Focus of the new PhD programs will be on: a) alternative fuels and combustion processes: biofuels, e-fuels, natural gas, dual-fuel, spark-assisted CI; b) gas exchange, turbocharging, after-treatment systems; c) zero-impact emission engines. http://www.engines.polimi.it/research/
Methods and techniques that will be developed and used to carry out the research	Investigation and optimization of new engines will be carried out by development of advanced CFD (OpenFOAM, LibICE library) and 1D (Gasdyn) fluid dynamic models.
Educational objectives	To provide a cutting-edge know-how in IC engine modelling and meet the ever increasing needs of zero impact emissions and lower fuel consumptions.
Job opportunities	Applied research in IC engine design and optimization within industry or university. There is a wide number of international and national industrial collaborations with a strong request of high profile CFD specialist in engine modelling.

Composition of the research group	2 Full Professors 3 Associated Professors 1 Assistant Professors 7 PhD Students
Name of the research directors	Angelo Onorati

Contacts
Email: angelo.onorati@polimi.it Ph: +39-022399-8416 http://www.engines.polimi.i

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

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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: CLEAN ENERGY CONVERSION SYSTEMS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	Concerns related to climate change are the main driving forces of the interest toward zero (or quasi zero) emission electricity production systems, based on renewable energy sources (e.g. concentrated solar power, wind, biomass, advanced photovoltaics) as well as carbon capture and sequestration. Research activities address also fuel cells, advanced micro-cogeneration, energy storage, hydrogen production, energy saving solutions and application to mobility. For more information about activities and laboratories of the research group: www.gecos.polimi.it
Methods and techniques that will be developed and used to carry out the research	Research activity is (a) theoretical and focused on simulation and optimization of complex, multi-energy systems and advanced components; and/or (b) experimental carried out in the laboratories located in the Bovisa campus and active cooperation with foreign labs.
Educational objectives	The PhD candidate will work in a highly motivated and qualified large research group ranked at the top position of the Italian university system. The PhD candidate will gain experience, knowledge and skills in cutting edge technologies of the power generation and energy conversion field, with possible nvolvement in international and EU projects as well as in the cooperation

	with leading universities, industries and R&D institutions.
Job opportunities	This research activity will qualify the candidate for future academic and research positions, as well as for a highly qualified professional career in industries or organizations operating in the energy field.
Composition of the research group	5 Full Professors 5 Associated Professors 8 Assistant Professors 35 PhD Students
Name of the research directors	Paolo Chiesa, Stefano Campanari, Matteo Romano

Contacts
www.gecos.polimi.it paolo.chiesa@polimi.it stefano.campanari@polimi.it matteo.romano@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
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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: CO2 CAPTURE TECHNOLOGIES FOR THE INDUSTRIAL SECTOR

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	Industrial sector full decarbonization is one of the main challenges of the EU pathway towards Net Zero Emissions. In this context, the hard-to-abate industry, such as cement, steelmaking, oil&gas, chemicals, glass manufacturing, pulp and paper need to deeply rely on CO2 Capture Utilisation and Storage technologies. Research activities will focus on process modelling, techno-economic analysis and optimization of CO2 Capture technologies, covering also the integration with the hosting industrial facilties, to exploit synergies and process integration aspects. The following specific goals will be targeted: • Develop validated process models for the hard-to-abate industrial process to be decarbonized (e.g. cement kiln), in terms of energy and mass balances • Study the optimal plant design and process integration, and calculate the performances by means of ad hoc numerical models (e.g. developed in Matlab, Python or Excel) and specialized process simulation tools (Aspen Plus, Thermoflex, gProms, etc.) • Size and Design pilot plant at medium-to-high Technology Readiness Level • Carry out experimental tests with pilot facilities, if

	envisaged • Carry out techno-economic analyses for the full-scale application of the technology The PhD activity will be carried out in strict collaboration with GECOS (www.gecos.polimi.it/staff/) and LEAP research teams. LEAP (Laboratorio Energia e Ambiente Piacenza, ww.leap.polimi.it) is a research center participated by Politecnico di Milano.
Methods and techniques that will be developed and used to carry out the research	The project will be highly inter-disciplinary: energetic, thermodynamic, chemical and both modelling and experimental capabilities will be developed and applied to study and compare different decarbonization technologies (e.g. carbon capture, use of biomass, etc.). The research activity will be based either on data from real plants or from models/literature. Energy systems and process engineering analysis tools and software (e.g. Aspen Plus, Matlab, Thermoflex, etc.) will be used for process modelling and simulation purposes. Experimental activities at LEAP lab located in Piacenza, or in active cooperation with foreign Universities will be pursued.
Educational objectives	The main goal is to educate a professional profile with a specialized R&D know-how in the field of process design and integration, decarbonization of hard-to-abate industry and carbon capture technologies. The PhD candidate will be involved in international and EU projects and in collaborative projects with leading R&D centers, universities and industries.
Job opportunities	The PhD research will qualify the candidate with skills in applied research and technology transfer in the field of low-carbon technologies and in the sector of CCUS. In these areas, Politecnico di Milano and LEAP are involved in international collaborative research projects in partnership with companies and other R&D institutions.
Composition of the research group	1 Full Professors 0 Associated Professors 2 Assistant Professors 4 PhD Students

POLITECNICO DI MILANO

Name of the research directors	Manuele Gatti and Stefano Consonni

Contacts
manuele.gatti@polimi.it **stefano.consonni@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

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.

POLITECNICO DI MILANO

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

THEMATIC Research Field: DEVELOPMENT OF AN AIR HUMIDIFICATION SYSTEM FOR POLYMER ELECTROLYTE MEMBRANE FUEL CELL FOR HEAVY DUTY VEHICLES

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0 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	A consistent public and private funding is dedicated worldwide to improve efficiency and sustainability in the automotive sector through the development of hydrogen technology, with particular focus to proton exchange membrane fuel cells (PEMFCs). In this context, the control of air humidity plays a crucial role to guarantee high efficiency and durability of the stack. The research project aims to develop an innovative membrane-based air humidifier, through the following main activities: i) development of phenomenological model of the device; ii) preparation and characterization of polymeric membranes; iii) prototyping of the device; iv) experimental analysis of the prototype; v) modeling and experimental analysis of the humidifier integrated with PEMFC.Finally, prototype performance will be compared with ones of commercial components in steady state conditions and under standard automotive cycles. System design will consider both performance and durability.
Methods and techniques that will be developed and used to carry out the research	The experimental analysis will be carried out through the experimental facilities available at AirLab and MRT Fuel Cell Lab research groups, appropriately integrated for this project. Modeling tools will be developed in the two research groups to simulate the entire system (dynamic simulations in Matlab or Simulink) or each independent component (with Matlab or CFD codes).

Educational objectives	The student will deepen his/her knowledge in thermodynamics and transport phenomena. Learning of advanced mass transport measurement techniques, transport phenomena and fluid dynamics modeling, coordination of activities is also expected.
Job opportunities	Placement in enterprises operating in advanced material, electrochemistry and energy sectors. The acquired experience permits to continue the research career in academia and in research centers.
Composition of the research group	2 Full Professors 4 Associated Professors 3 Assistant Professors 6 PhD Students
Name of the research directors	Stefano De Antonellis

Contacts
stefano.deantonellis@polimi.it +390223993823 www.polimi.hvac.it www.mrtfuelcell.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	750.0 €
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.

POLITECNICO DI MILANO

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

THEMATIC Research Field: DEVELOPMENT OF CO2 CAPTURE PROCESS WITH THERMOCHEMICAL ENERGY STORAGE

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0 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	Agreements on global environmental policies like the one in Paris recently revisited and reinforced during the COP26 in Glasgow, keep in sight to limit the increase in global temperature to 1.5°C above pre-industrial levels by 2100. This goal will imply a substantial paradigm shift for power generation from fossil fuel-based plants to renewable energy sources. However, high penetration of non-dispatchable nor programmable renewables are posing a challenge in terms of grid stability until large-scale and low-cost energy storage systems are fully available. Consequently, in the following decades, power generation from fossil fuels will likely still play a role, gradually shifting from baseload to mainly load-following and finally to backup operations. In order to comply with the technical and environmental requirements, it is necessary to adapt the existing plants to low-capacity factors, high flexibility, and cleaner schemes where carbon capture and storage play a dominant role. Calcium looping (CaL) appears to be perfectly suitable for this retrofitting application since it relies on the utilization of inexpensive and easily storable solid sorbent that, for a backup plant, could be stored in a large amount at low temperature, unlocking the possibility to decouple carbonator and calciner islands operation at low cost. Substitution of the sorbent from CaO, as adopted in traditional CaL to $Ca(OH)_2$, is considered very promising

	in this context thanks to the faster kinetics for the carbonation reaction, which would allow decreasing the required residence time to achieve high CO_2 conversion, thus, allowing the utilization of reactors (once through entrained flow and cyclonic reactors) cheaper than typical fluidized bed reactors.
Methods and techniques that will be developed and used to carry out the research	The researcher is required to develop the numerical models necessary to study the chemical behavior of the reactors and the thermodynamic behavior of the different sections of the plant to perform technical and economic analysis. Commercial software (Aspen, Thermoflex) and in house codes (Matlab) will be adopted. The project will be based on the following WPs: **WP1: CARBONATOR MODELLING**This WP focuses on the development of a next generation one-dimensional model for the entrained flow reactor adopting $Ca(OH)_2$ that will be validated and calibrated on experimental results. The model predictions will be used in the process design and simulation tasks by establishing quantitative relationships between reactor performance parameters and operation conditions and other input data. Outputs from reactor models of carbonation will be implemented in wider process simulations tools used in WP2 and WP3. **WP2: FULL PROCESS SIMULATION**In this WP the overall process scheme will be fully solved and integrated from a mass and energy point of view. The target is to identify cost-efficient configurations with minimum complexity during the carbonation stage, as this is the step that requires lowest specific capex. Optimum thermal integration during calcination and subsequent hydration for sorbent regeneration is also a priority objective in the overall system, as these steps are expected to operate in steady-state in long periods when the back-up coal power is off. Different heat-exchanger steps to use the heat leaving the carbonator with the flue gas and the carbonator solids will be analyzed to reduce the temperature of the stored $Ca(OH)_2$ and $CaCO_3$ materials and utilize the contained heat efficiently (e.g. by using schemes as suspension preheaters available in cement

	plants). The hydrator reactor characteristics will also be integrated with the process model. The process model will also include the calciner block and the power plant associated to this reactor. Possibilities to thermally integrate the waste heat streams into the coal power plant (for example by using residual heat in the stored solid reservoirs for water preheaters) will also be investigated. The main results of this process modelling activity are the overall heat and energy balances of the process, which will be used in WP3 for economic assessment of the process. **WP3: TECHNO ECONOMIC ANLAYSIS**The cost of the electricity produced by the process will be compared against the cost of power-to-fuel-to-power schemes operated under the same boundaries (i.e. for the same cost of carbon-free electricity supply during charge periods and similar type and duration of back-up power generation and charge periods). Gas turbines operated as back-up systems and power-to-gas-to-power process will be used as benchmarks options for this analysis
Educational objectives	The PhD candidate will: • Become expert of process simulation of calcium looping process for fossil fuel power plant. This expertise can be easily adapted to process simulations of energy conversion processes. • Become expert in critically analysing the performance of energy conversion processes from energy, environmental and economic points of view.
Job opportunities	Apart from academia and research institutes, the main expected job opportunities after the PhD will be in industrial sectors (e.g. cement, steel, oil & gas, electric utilities), that in the next decade will implement innovative processes and technologies to reduce their carbon footprint.
Composition of the research group	4 Full Professors 6 Associated Professors 10 Assistant Professors

	4 PhD Students
Name of the research directors	19

Contacts
Marco Astolfi *marco.astolfi@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	750.0 €
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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: FLUID-DYNAMICS OF TURBOMACHINES

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	To deepen the understanding of complex fluid dynamic phenomena occurring in modern and non-conventional turbomachines with the aim to support performance improvement and design optimization, with particular emphasis on: -unsteady interactions in axial & radial turbomachines, -fluid dynamics of turbomachines operating with real gases for ORC and CO2 power plants. -Vertical and horizontal axis wind turbines -To develop novel measurement techniques and numerical codes for fluid dynamic applications. -Design of special turbomachines Info at: http://www.lfm.polimi.it
Methods and techniques that will be developed and used to carry out the research	Advanced measurement techniques for compressible, incompressible and unsteady flows, such as Fast response pressure probes, LDV, PIV, HW. Advanced mathematical models for data reduction and analysis. State of art CFD codes for 3D unsteady flows, including viscous and real gas, two-phase flows, design & optimization methods.
Educational objectives	To provide a high level knowledge about advanced compressible fluid dynamics in the field of turbomachines. Up-to-date skills for turbomachinery design and

	optimization.
Job opportunities	National and international companies in the field of power generation, aero-engine, aero-space, oil & gas. Consultancy companies. Private and public research centers.
Composition of the research group	2 Full Professors 2 Associated Professors 1 Assistant Professors 4 PhD Students
Name of the research directors	V. DOSSENA, P. GAETANI, G. PERSICO

Contacts
paolo.gaetani@polimi.it vincenzo.dossena@polimi.it giacomo.persico@polimi.it andrea.spinelli@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

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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: FUEL CELLS AND ELECTROCHEMICAL BATTERIES

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0 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	A consistent public and private funding is dedicated worldwide to improve electrochemical energy technologies to improve efficiency and sustainability of the energy sector. In the MRT Fuel Cell & Battery Laboratory the critical phenomena occurring in low temperature fuel cell (PEMFC), flow battery (VRFB) and lithium-ion battery are investigated. Characterization, development and optimization of innovative components and operating strategies are carried out to improve performance and lifetime, participating to ongoing projects.
Methods and techniques that will be developed and used to carry out the research	The student will be involved in advanced experimental activities regarding characterization and design of innovative electrochemical devices at MRT Fuel Cell & Battery Laboratory, coupling modeling activities to increase the understanding of occuring phenomena and develop novel components and operating strategies.
Educational objectives	The student will deepen his/her knowledge in electrochemistry, thermodynamics and transport phenomena. Learning of advanced electrochemical and mass transport measurement techniques, transport phenomena modeling, coordination of activities is also

	expected.
Job opportunities	Placement in enterprises operating in advanced material, electrochemistry, energy and automotive sectors. The acquired experience permits also to continue the research career in academia or in research centers.
Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 6 PhD Students
Name of the research directors	A. Casalegno, A. Baricci, C. Rabissi, M. Zago

Contacts
andrea.casalegno@polimi.it +390223993912 www.mrtfuelcell.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	750.0 €
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.

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
Riccardo Mereu - riccardo.mereu@polimi.it Federico Piscaglia - federico.piscaglia@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	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.

POLITECNICO DI MILANO

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

THEMATIC Research Field: INVESTIGATION AND MITIGATION OF FULL SCALE POLYMER ELECTROLYTE MEMBRANE FUEL CELL DEGRADATION MIMICKING REALISTIC HEAVY DUTY TRANSPORT APPLICATIONS

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0 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	Hydrogen produced from renewable resources, universally known as green hydrogen, is becoming a crucial asset to tackle the impact of climate change in those hard-to-abate sectors in which no competitive and scalable technology is currently available for decarbonization. These sectors are responsible for nearly one-third of global carbon emission, but projections indicate their share will increase significantly in the future. Heavy-duty transport, i.e. road trucks, maritime and rail, is a hard-to-abate sector for which hydrogen fuel cells could be an efficient, scalable, reliable and climate neutral solution. Hydrogen fueled polymer electrolyte fuel cell (PEMFC) is a commercially available technology in the automotive sector that was already demonstrated for heavy duty transport applications, however the state-of the-art technology requires yet an improvement in durability to overcome barriers in the commercialization. The research project aims to develop and validate simulation tools able to predict the performance loss under real world operation for heavy duty applications. The following work packages are identified: a) analysis of the applications to understand real world operating conditions and define proper driving cycles; b) experimental analysis of the durability in single cell under accelerated stress test to estimate the effect of operative

	conditions; c) development and validation of degradation models to predict the evolution of material properties during ageing; d) development and validation of steady state and transient modelling tools to predict performance loss.
Methods and techniques that will be developed and used to carry out the research	The experimental analysis will be carried out through the experimental facilities available at MRT Fuel Cell Lab research group and Pro-e-Storage laboratory, with a specific focus on electrochemical techniques (polarization curves, electrochemical impedance spectroscopy, voltammetry). Modeling tools will be developed starting from proprietary codes (Matlab or Simulink) to simulate degradation models and performance models.
Educational objectives	The topic is extremely interdisciplinary. The student will deepen his/her knowledge in thermodynamics, electrochemistry, electrical engineering and transport phenomena, as well as on theoretical and experimental tools.
Job opportunities	Placement in companies operating in the field of automotive/transport sector, advanced materials, modelling of energy systems.
Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 5 PhD Students
Name of the research directors	Andrea Baricci; Andrea Casalegno

Contacts
E-mail: andrea.baricci@polimi.it Web-site: www.mrtfuelcell.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	750.0 €
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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: LOW EMISSION TECHNOLOGIES FOR WASTE AND BIOMASS VALORISATION

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	Waste and Biomass are resources that can effectively contribute to the energy transition within the framework of the Circular Economy. However, specialised technologies are required to exploit their potential in an environmentally friendly way. Both theoretical/numerical and experimental approaches are required to support the development of such technologies, as well as a research infrastructure that facilitates industry-academia interaction and technology transfer. This PhD theme is promoted by a research group that has a stable collaboration with the LEAP Lab (www.leap.polimi.it), a consortium company participated by Polimi and active in the fields of waste and biomass valorisation with dedicated research programs.
Methods and techniques that will be developed and used to carry out the research	The research entails the development of numerical models based either on simulation programs (Thermoflex, Aspen Plus, proprietary tools) or Computational Fluid Dynamics software (OpenFoam, Comsol, etc.).Experimental activity can also be carried out, both at LEAP facilities and on plants of LEAP¿s industrial partners. Most of the research will be carried out in collaboration with researchers operating at LEAP Lab.
Educational objectives	To provide a cutting-edge know-how in Waste and Biomass valorisation and meet the ever-increasing needs

	of environmentally friendly technologies exploiting such resources.
Job opportunities	Applied research in Waste and Biomass valorisation field: design and optimization within industry or university of environmentally friendly exploitation technologies. There is a wide number of international and national industrial collaborations with a strong request of high profile specialists in this field.
Composition of the research group	1 Full Professors 1 Associated Professors 1 Assistant Professors 3 PhD Students
Name of the research directors	Stefano Consonni

Contacts
Prof. Stefano Consonni Ph. +39-0523-35-6873/7721 stefano.consonni@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

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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: MACHINE LEARNING BASED HVAC SYSTEM MODELLING

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	Data analytics and internet of things (IoT) have recently revolutionized several different sectors and are accordingly receiving growing public funding and private investment. These trending technologies have specifically demonstrated their potential of providing the energy sector with several benefits and have consequently received increasing attention in this field. In the Data Analytics and Optimization for Energy Applications Laboratory, hybrid data-driven and physical phenomena based models are developed in order to accurately simulate the behaviour and subsequently optimize the performance of energy systems. Advanced data analytics methods along with in-depth knowledge of the corresponding physical phenomena, are being employed in the lab for improving the dynamic performance of heat generation units, behaviour prediction of heat consuming processes, diagnosing the faults in the advanced power generations systems, and optimizing the long-term efficiency of CHP plants. Research activities of the laboratory also include smart meter analytics, data-driven building performance prediction and hybrid data-driven/physical based modelling of heat transfer and pressure drop. The lab is performing projects in collaboration with large-scale Italian industrial partners and is conducting joint research activities with international academic partners.

Methods and techniques that will be developed and used to carry out the research	The student will be involved in the advanced simulation activities, including the implementation of both data-driven and physical models, and experimental activities, which are conducted in collaboration with the industrial partners of the group.
Educational objectives	The student will deepen his/her knowledge of physical modelling including the simulation of thermodynamic and heat transfer phenomena. Besides, he/she will acquire expertise in the implementation of data-driven methodologies and learns about the corresponding underlying theoretical concepts.
Job opportunities	Placement in the large-scale companies, which are conducting activities focused on the applications of data analytics in the energy sector. The obtained experience will also permit the student to continue his/her research career in academia.
Composition of the research group	1 Full Professors 1 Associated Professors 1 Assistant Professors 1 PhD Students
Name of the research directors	Colombo Luigi P.M., Najafi Behzad, Rinaldi Fabio.

Contacts
fabio.rinaldi@polimi.it Tel. +39 02 2399 2342

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
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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: MICRO AND NANOSTRUCTURED MATERIALS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	Fabrication of innovative nanostructured thin films and surfaces, and their physical characterization (e.g. morphology, structure and electronic/optical properties) and computational modelling. Focus of the new PhD programs will be on: a) nanomaterials for applications in nuclear fission and fusion systems; b) nanomaterials for energy storage, photovoltaic, catalysis, sensing and thermoelectric applications; c) nanomaterials for superintense laser-matter interactions; d) novel 1D and 2D carbon-based nanomaterials based on carbon atomic wires; e) atomic scale surface science of novel 2D nanostructures.
Methods and techniques that will be developed and used to carry out the research	Material production by physical deposition techniques (e.g. pulsed laser ablation); material characterization mainly by spectroscopy and scattering techniques (Raman, Brillouin, X-ray) and high resolution microscopy techniques (scanning tunneling and atomic force microscopy, scanning electron microscopy). Suitable theoretical and numerical models for materials and plasmas description.
Educational objectives	Education of people to be launched in the world of

	research and technology in the field of physics and engineering of materials, able to manage interdisciplinary issues, perform and interpret complex experiments and produce new equipment.
Job opportunities	Private and public R. & D. Highly qualified positions in a wide range of industries related with production, development and use of materials.
Composition of the research group	3 Full Professors 4 Associated Professors 2 Assistant Professors 10 PhD Students
Name of the research directors	A. LI BASSI, M. PASSONI, C. CASARI

Contacts

Email: andrea.libassi@polimi.it
Ph: +39-022399-6316
Email: matteo.passoni@polimi.it
Ph: +39-022399-3267
Email: carlo.casari@polimi.it
Ph: +39-022399-6331

http://www.nanolab.polimi.it

List of 5 Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research

1. Oak Ridge National Laboratory (USA)
2. University of Manchester (UK)
3. CNR: Istituto di Fisica del Plasma and Institute for Microlectronic and Microsytems (Italy)
4. Tonji University (Shangai, China)
5. EUROfusion (EU)

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

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.

POLITECNICO DI MILANO

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

THEMATIC Research Field: MODELLING OF CEMENT PLANTS WITH ALTERNATIVE FUELS AND CO2 CAPTURE

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0 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	After water, cement is the most widely used substance on Earth accounting for around 6-7% of total CO2 emissions on a global scale. Decarbonizing cement industry is particularly challenging, as most of CO_2 emissions are 'process emissions' that derive from the decomposition of $CaCO_3$ into CaO + CO_2 and therefore cannot be avoided via electrification or by using renewables. For this reason, cement industry is considered a hard-to-abate sector. Reducing CO_2 emissions while producing enough cement to meet demand in the coming decades will require multiple strategies such as improving energy efficiency, switching to lower-carbon energy sources, promoting material efficiency (e.g. reducing the clinker-to-cement ratio) and advancing process innovations such as CO_2 capture and storage technologies (www.iea.org/reports/cement).This PhD project is co-funded by the 'Innovandi program' of the Global Cement and Concrete Association (https://gccassociation.org/innovandi/). This will involve the exposure to the main World cement industries and academic research groups in the sector, with periodic meetings to present the progress of the work.
Methods and techniques that will be developed and used to carry out the research	The overall scope of the project is twofold: (1) to understand the potential of a hybrid approach including physically-driven models and plant data to

	predict and optimize cement plants performance and clinker and cement quality; (2) to carry out modelling of cement kilns fed by alternative fuels AF (e.g. biomass, waste derived fuel, etc.) and/or equipped with CO2 capture technologies. Both goals aim at decarbonizign the cement sector. The project will be based on the following work packages which may be further refined in due course (WP). The following is a tentative list of WPs: **WP1 - Process modelling for clinker production:** Starting from measured data from real plants, the PhD student will model the clinker production process and simulate the mass & energy balance, while computing the Key Performance Indicators for a selected number of cement facilities, under different input conditions. Models will be developed via a proper combination of process simulation environment, such as Aspen Plus, Matlab, Excel, etc. **WP2 - Development of Input-output relationships between process variables and plant parameters:** Combining measured data from real plants with the process models from WP1, the PhD student, in collaboration with other institutions (e.g. IIT Delhi), will develop 'black-box' and 'data-driven' models in order to relate operating parameters and plant emissions. **WP3 - Process modelling and Techno-Economic Assessment of cement plants with AF and CO2 capture:** The PhD student will then extend the modelling work in order to describe the impact of alternative fuels on the energy performance and mass balance of the cement kiln. Moreover, a significant part of this WP will be dedicated to building process models of CO2 capture technologies to be integrated with cement plants. Finally, techno-economic analyses will be carried out to benchmark the performance and costs of the different plant configurations envisaged.
Educational objectives	The PhD candidate will: • Become expert of process simulation of advanced cement production processes. This expertise can be easily adapted to process simulations of energy

	conversion processes. • Become expert in critically analysing the performance of energy conversion processes from energy, environmental and economic points of view. • Acquire specific modelling and experimental experience on alternative fuel technologies and CO2 capture processes for the hard-to-abate industry. • Acquire experience in the field of machine-learning and data driven approaches applied to cement plants.
Job opportunities	Apart from academia and research institutes, the main expected job opportunities after the PhD will be in hard-to-abate industrial sectors (e.g. cement, steel, oil & gas, chemical industry, waste-to-energy), that in the next decade will implement innovative processes and technologies to reuce their carbon footprint.
Composition of the research group	4 Full Professors 6 Associated Professors 10 Assistant Professors 19 PhD Students
Name of the research directors	Manuele Gatti and Matteo Carmelo Romano

Contacts
manuele.gatti@polimi.it matteo.romano@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	750.0 €
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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: MULTISCALE ENERGY SYSTEM MODELLING (MESYM)

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	Quantitative assessment and reduction of the impact that modern industrial and productive systems have on the environment is one of the major challenges in engineering and environmental sciences. This claim is quite evident in both the new Agenda 2030 and the 17 Sustainable Development Goals by the UN as well as in the declaration from COP21 and in the EU 202020 objectives.Due to the complex and interdependent nature of such processes, an integrated and multiscale approach is currently claimed, able to model a variety of different phenomena at both small and large scales, focusing at local and global quantities. In line with this objective, the research aims at developing innovative and integrated modeling frameworks, using the most appropriate methodology based on the analyzed scale: - **Small-scale systems** (the scale of the components/plants): thermodynamic-based methods (i.e. Energy and Exergy analyses), Computational Fluid Dynamics (CFD) and Lumped Parameter Model (LPM) analyses. - **Meso-scale systems** (networks of productive systems): agent-based models, simulation and optimization models, planning tools. - **Large-scale systems** (productive sectors of countries): empirical models based on Input-Output

	analysis and Life Cycle Assessment.The development and joint application of these methods will enable to assess the impact of different systems, and to define suitable strategies to reduce it, hence fostering sustainable development
Methods and techniques that will be developed and used to carry out the research	**Theoretical tools:** Thermodynamics, Exergy based methods, LPM, CFD, Energy modeling, Input-Output analysis, Life Cycle Assessment. **Computational tools:** ANSYS Fluent, Cycle-Tempo, Engineering Equation Solver (EES), GAMS, Matlab, MicroGridsPy, OpenFOAM, Python, Ramp, Simapro,..
Educational objectives	The objectives are to develop/implement and validate: - integrated Multiscale Energy Systems Models, to perform economic and environmental impact assessment of industrial, urban and residential and productive systems; - Multiscale Thermo-Fluid Dynamic models, to perform performance assessment and optimization of industrial and productive components and sub-systems.
Job opportunities	Energy Analyst for energy utilities and/or for NGOs and international organization or public institutions.
Composition of the research group	2 Full Professors 0 Associated Professors 4 Assistant Professors 10 PhD Students
Name of the research directors	Emanuela Colombo; Fabio Inzoli

Contacts
emanuela.colombo@polimi.it fabio.inzoli@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

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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: NEXT GENERATION NUCLEAR REACTORS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	Development of innovative Nuclear Reactors (GenIII+ and Gen IV) and their adoption in Hybrid Systems scenarios to face climate change. Focus on international and EURATOM funded R&D projects: Small Modular Reactors, Lead/Lead-Bismuth/Sodium cooled Fast Reactors, Molten Salt Reactors, reactors for space applications. Theoretical, numerical and experimental research activities (e.g., at Dynamo Labs-POLIMI, SIET Labs-Italy, JRC Karlsruhe-Germany, JRC Petten-The Netherlands, CEA-France) available on topics: thermal-hydraulics, CFD, thermo-mechanics, safety, performance analyses of innovative fuels and structural components, dynamics & control, reduced order, multi-physics and multi-scale modelling, techno-economic analysis. Internships abroad (EURATOM and ENEN partners) will be planned. Quick overview of the R&D group: http://www.nuclearenergy.polimi.it
Methods and techniques that will be developed and used to carry out the research	Simulation tools to be used/developed: RELAP (safety), TRANSURANUS/BISON/SCIANTIX/MFPR-F/ABAQUS (fuel, thermo-mechanics), MCNP/SERPENT (neutronics), OpenFOAM, FLUENT (CFD), MODELICA (object oriented modelling), COMSOL (Multiphysics), Matlab-Simulink (model predictive control).

POLITECNICO DI MILANO

Educational objectives	To gain a high-qualified know-how and expertise in the nuclear energy & innovative reactors area, with a balanced experimental and modelling approach. To be able to operate within international teams.
Job opportunities	Strong need of new nuclear experts: to substitute a generation of experts in the retirement phase; European nuclear industry activities for post-Fukushima retrofit on current fleet; new nuclear build in EU and in the international market; new start-ups in the nuclear sector (SMRs, GenIV reactors); International Research Centres.
Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 10 PhD Students
Name of the research directors	Marco Ricotti, Antonio Cammi, Lelio Luzzi

Contacts
http://www.nuclearenergy.polimi.it *marco.ricotti@polimi.it* *antonio.cammi@polimi.it* *lelio.luzzi@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
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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: NUCLEAR MEASUREMENTS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	To study and develop innovative detectors for the dosimetry of the irradiation fields for hadron therapy. The research is focused mainly on silicon microdosimetry and avalanche-confinement TEPCs, but other techniques will be studied.
Methods and techniques that will be developed and used to carry out the research	Measurement of the detector response to characterize radiation fields. Monte Carlo simulations of the detector response. Development of analytical methods for the determination of the detector response functions. Development of innovative methods for data analysis. Development of low-noise electronics.
Educational objectives	To gain a high-level knowledge about radiation dosimetry, microdosimetry, low-noise electronics and medical applications of radiation fields.
Job opportunities	Radiation detector industry, hadron therapy facilities, particle accelerator industry and research centres.
Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 1 PhD Students
Name of the research directors	Stefano Agosteo, Andrea Pola

Contacts

Email: stefano.agosteo@polimi.it
Ph: +39-0223996318
http://www.energia.polimi.it/dipartimento/scheda_persona.php?id=84

Email: andrea.pola@polimi.it
Ph: +39-022399634
8http://www.energia.polimi.it/dipartimento/scheda_persona.php?id=48

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

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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: RADIOCHEMISTRY, RADIATION CHEMISTRY AND NUCLEAR WASTE

Monthly net income of PhDscholarship (max 36 months)
€ 1300.0 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	The research addresses current environmental and security issues arising from the production of energy by nuclear fission and the industrial exploitation of ionizing radiation. In particular, the main research lines are: 1.hydrometallurgical advanced reprocessing for separating actinides and fission products from spent nuclear fuel. 2.fuel-coolant chemical interactions and corrosion phenomena in Gen IV nuclear systems. 3.new solid matrices for nuclear waste confinement. 4.radiation damage on organic systems for reprocessing and inorganic matrices for confinement. 5.radio-induced modifications on materials for radiation processing; dosimetric systems for medical applications; food irradiation. 6.Nuclear Decommissioning 7.treatment processes for nuclear waste 8.radiochemical methods for radioactive contaminants and hard-to-measure radionuclides
Methods and techniques that will be developed and used to carry out the research	1. Solvent extraction for actinide/lanthanide/fission products separation. Nuclear measurements and

	analytical chemistry techniques (ICP-MS, ICP-OES, LSC, UV-VIS, NMR, ESI-MS etc.) for fuel partitioning studies. 2. Raman scattering, X-ray fluorescence and diffraction, SEM, mechanical and leaching resistance tests for characterization of waste confinement matrices. 3. gamma-irradiation, HPLC, MS, NMR and EPR spectroscopy for radiolytic products characterization. 4. GPC, PALS, FT-IR and EPR for materials studies. 5. UV-VIS and MRI for absorbed dose measurement. 6. Radiochemical methods for Nucl. Decommissioning, incl. Nuclear measurements techniques (alpha spectrometry, LSC, ICP-MS etc.) 7. Monte Carlo codes for radiation transport shielding and dose evaluation for radioprotection calculations. 8. Density Functional Theory simulations for Gen IV studies.
Educational objectives	To gain a cutting-edge know-how from the viewpoints of radiochemistry, radiation chemistry and nuclear waste management in the abovementioned research fields. To develop experimental and computational research to tackle multidisciplinary and complex issues, taking advantages from the new nuclear laboratories, equipment, facilities and the strong experimental background of the research group. To collaborate within international contexts (EURATOM/H2020, IAEA, JPNM-EERA, ENEN2Plus Collaborative Projects).
Job opportunities	In the field of nuclear and chemical activities for energy production and Gen IV systems; national and European industries involved in nuclear decommissioning, management and disposal of nuclear and industrial waste; International Research Centres.
Composition of the research group	1 Full Professors 0 Associated Professors 2 Assistant Professors 2 PhD Students
Name of the research directors	Mario Mariani, Eros Mossini, Elena Macerata

Contacts
mario.mariani@polimi.it; +39 02 2399 6358 (6395) http://www.radiochimica.polimi.it https://www.youtube.com/channel/UCKh-HxSAWYhhNX076uuvTOA/videos

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	650.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Educational activities supported by purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences according to the R&D needs and opportunities Teaching assistanship by means of 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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: SAFETY AND RISK ANALYSIS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 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	The aim of the research study is to develop and apply in practice advanced methods and techniques of modeling, numerical simulation, data analysis (including artificial intelligence and machine learning) for advanced reliability, availability, maintainability (RAM) analysis, prognostics and health management (PHM), predictive maintenance and condition-informed risk and resilience assessment of complex systems and critical infrastructures, e.g. in the nuclear, oil and gas, energy, transportation and other industries. The research findings will be applied and tested on real case studies, in collaboration with industries of the energy sector. Scientific experiences abroad will be strongly encouraged.
Methods and techniques that will be developed and used to carry out the research	Probabilistic Modeling, Markov Chains, Bayesian Belief Networks, Monte Carlo Simulation, Particle Filtering, Neural Networks, Support Vector Machines, Deep Learning, Convolutional Neural Networks, Generative Adversarial Networks, Reservoir Computing, Fuzzy Logic, Possibility Theory, Statistical Physics, Graph Theory, Genetic Algorithms, Evolutionary Optimization, Reinforcement Learning.
Educational objectives	To prepare a RAMS (Reliability, Availability, Maintainability and Safety)/Risk and Resilience professional expert and competent researcher with the

	technical skills, algorithmic knowledge and system analysis capabilities for evaluating and making decisions for preventing and managing the risks of complex technological systems, with specific domain expertise in the energy field.
Job opportunities	RAMS, reliability, maintenance, safety, risk engineer and manager, data analyst in support of decision making for complex systems (e.g. aerospace, nuclear, chemical, energy generation and distribution, etc.) design, operation, management and regulation.
Composition of the research group	2 Full Professors 1 Associated Professors 1 Assistant Professors 12 PhD Students
Name of the research directors	Enrico Zio

Contacts
Email: enrico.zio@polimi.it Ph: +39 02 2399 6340 www.lasar.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

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.

POLITECNICO DI MILANO

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

OPEN SUBJECT Research Field: THERMALLY DRIVEN CYCLES FOR HVAC

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0 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	Thermally driven and hybrid compression absorption heat pumps have the potential to provide high temperature heat for space heating and hot water production in civil and industrial applications. However, to make this possible, research is still needed to improve the design of the main components (heat exchangers, pump, compressor). The objectives of the research are design and optimization of a prototype absorption cycle, modelling and experimental characterization of fluid dynamics phenomena in ammonia-water absorbers and generators, investigation on control and safety issues.
Methods and techniques that will be developed and used to carry out the research	Numerical modelling of two-phase flow, heat and mass transfer Prototyping and experimental validation of heat exchangers Experimental characterization of absorption heat pump appliances in accredited laboratory
Educational objectives	To deepen knowledge in heat transfer and thermodynamics applied to building thermal physics and energy processes in heating and cooling of buildings. To provide modelling kills and critical knowledge in the usage of dynamic simulation tools.
Job opportunities	R&D within the heating industry (HVAC, gas boiler

	manufacturers) Research in academia or public and private institutions Energy Services Energy Management and Energy Auditing Companies
Composition of the research group	1 Full Professors 2 Associated Professors 4 Assistant Professors 4 PhD Students
Name of the research directors	prof. Mario Motta, prof. Livio Mazzarella

Contacts
mario.motta@polimi.it marcello.aprile@polimi.it tommaso.toppi@polimi.it Research group: Buildings' Environment and Energy Systems (BEES) https://www.energia.polimi.it/dipartimento-di-energia/ricerca/gruppi-di-ricerca/sistemi-energetici-e-ambientali-negli-edifici-bees/

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

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.