PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.01

Curriculum: 3. Technology and Territory

ITA: Gestione dell'energia: perfezionamento degli studi energetico-ambientali finalizzati alla carbon reduction. EN: Carbon reduction target: supporting the energy-environmental management studies (with a focus on consulting services)

Reference Person: Anglani Norma (norma.anglani@unipv.it)

Host University/Institute: University of Pavia

Research Keywords:	Energy-environmental studies, enhancement of professionals' competences
	Artificial intelligence and machine learning
	Optimized energy configurations from the carbon neutrality standpoint
Reference ERCs:	PE7_2
	PE7_3
	PE7_12
Reference SDGs:	GOAL 4: Quality Education, GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The pragmatic objective of the research is an enhancement in innovation of processes and services of in the energy-environmental consulting.

The main aim is to support the job profile of professionals in the environmental-energy consulting field by providing more interdisciplinary tools related with the concept of sustainability (specifically, carbon neutrality) and therefore a partnership with an already identified consulting company in the energy field will strengthen the project.

Carbon neutrality means the full offset of an equivalent level of carbon dioxide emissions, due to a specific activity, event, product, or service.

All sectors -from industry to the civil sector- are called to contribute to this achievement and the role that energy consultants will have to play, will become increasingly crucial.

The research will focus on the use of artificial intelligence (AI)/ machine learning (ML) techniques to improve (i) both benchmarks in the elaboration of energy-environmental models (from a microgrid up to a whole service), and (ii) the reliability of the results of the studies, in support of a progressive carbon neutrality.

Practically, how to use new techniques, will allow to establish unconventional correlations between different datasets for the evaluation of appropriate Key Performance Indicators (KPIs), addressing in a more and more precise way the technical-economic feasibility of an energy efficiency action or measure.

Not only AI/ML will be used but also LCA approach (life cycle assessment) under the carbon footprint standpoint will be applied to services (as for instance to a local healthcare system) or product such as a power converter (one of the major elements for the spreading of more renewable and smart/ microgrids) to study their impact.

Methodologically, the work of the candidate will start with a bibliographic analysis of the current use of AI/ML techniques in the field of energy consulting, still in its infancy, and it will proceed with the search for open-source datasets and cataloguing of potentially useful information, depending on the studies to be produced, constantly interfacing with the company.

Then it will move on to analysis tools by evaluating the use of useful packages for scientific calculation, machine learning and processing on large data (i.E. Anaconda, an open source distribution of Python (and R)). The choice of the tool is important especially considering market-oriented applications, which must efficiently support the presentation to the customer of the used methodology.

In this context, AI/ML is seen as a set of approaches, methods, and technologies helping to consider - with an increased degree of autonomy and reliability - possible relationships between information, which cannot be directly linked. This, to support the identification of benchmarks, useful to assess the energy/economic impact of actions/ technologies that lead progressively to carbon neutrality of for instance the LCA studies

Objectives and results: proficiency in the use of these tools allows to create an analytical ability to search for the best tools to refine the investigation and to correlate information supporting the energy studies towards carbon-neutrality.

Research team and environment

The candidate will be part of a wide-interest small research group, mainly made up of electrical and electronic engineers, all devoted to research dealing with energy management and power electronics, nonetheless the candidate will be able to benefit by the wide international contacts the group has been building over the years and also from the presence of AI/ML teams working at UNIPV.

The group (affiliated to the energy lab -LABEN- and power electronics Lab PEDEN1) is made up of one full, one associate professor, one assistant professor (from 2022) and several PhD candidates. Exchanges and stages abroad are encouraged to foster an open minded and fruitful personal growth. The candidate will have to be keen to group work.

Besides, the partnership with the consulting company will provide several assets such as: i) the PhD candidate will split her/his time between the university lab (first period) and the company (last period), so to test the new skills on AI/ML and LCA on international case studies, ii) the research activities will be carried out along with a placement activity. This is also in favor of an action of empowerment of PhD holders in the energy consulting companies

PI CV: Prof Norma Anglani received her MEng degree in Electric Engineering and her Ph.D. In Electrical Engineering from the University of Pavia (Italy) in 1993 and 1999 respectively. Since 1999 through 2001 she has been post-doctoral fellow at the Lawrence Berkeley National Laboratory both in the Energy Analysis Group and in the Energy Efficiency Standards group. In 2002 she became Assistant Professor of Electrical Energetics at the same University. She is now Associate professor at the University of Pavia, Italy and her research field is energy efficiency and energy modelling. She was visiting scholar at Nottingham University, NTNU, Trondheim (Norway) and Northeastern University, Boston USA). She has published over 70 peer reviewed scientific papers.

Professor Anglani is currently IEEE Senior member, IEEE WiE member, IEEE-IAS and IEEE-PELS member. She served as IEEE-IAS WiE Liaison for the term (2019/2020). She is associate editor of the IEEE Transactions on Industry Applications, Guest Associate Editor for the Special Section on Emerging topics of power electronics interfaced battery energy storage system. She was in the Organizing Committees of ECCE since 2017 – through 2023 as WiE Chair, as well as Publication Chair, Vice Chair, Topic Chair, Session Chair and Reviewer and Speaker.

Norma Anglani has been PI and Co-I in industrial, EU and government funding bodies' grants and she holds collaborations with foreign institutions around the world.

Dr. Anglani research interests are in the area of energy and optimization of the energy resources both for industrial processes (e.G. Compressed air systems and use of efficient technologies) and for the civil sector. Currently, she is responsible for research activities in the field of energy management and have been supervised the works of several PhD students and junior researchers working on hybrid micro-grid and energy systems planning and optimization. Main scientific publications deal with (i) the role of renewables and the feasibility of hybrid micro- grids also in developing countries, remote settings and portable renewable generators with storage; (ii) compressed air systems and their optimization; (iii) a new energy system model for the sustainability of the Lombardy Region. Recently she was the PI for the elaboration of the next Sustainable Energy and Climate Action Plan (SECAP2019) with respect to the energy-related issues.

Https://scholar.Google.It/citations?user=kadIE0EAAAAJ&hl=it

For this scholarship it is planned a period of internship at *ALENS SrL, Pavia*

Suggested skills for this research topic

An electrical or energy engineering background is favourable for approaching the complexity of an energy/environmental study but also environmental engineering with a focus on renewable energy can be a suitable origin field.

Basic knowledge of Python or knowledge on ML/AI techniques is a very welcome addition

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD course). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.02

Curriculum: 3. Technology and Territory

Ocean space utilization for energy harvesting purposes

Reference Person: Arena Felice (arena@unirc.it)

Host University/Institute: Mediterranea University Of Reggio Calabria

Research Keywords:	Water wave mechanics Energy harvesting Offshore engineering
Reference ERCs:	PE8_3 PE8_5 PE8_6
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 13: Climate Action

Description of the research topic

The research program deals with the development of offshore islands (as fixed or floating structures) for ocean space utilization, in which wave (marine) energy is exploited for energy supplying and to reduce CO2 emissions.

The research activities will be developed by considering:

- analysis and development of innovative models, analytical and/or numerical, of marine structures (i.E. Fixed breakwater, offshore floating structures), with OWC devices;

- study of the hydrodynamics problems for the modelling of large floating structures, including structures in which OWC devices are embodied;

- risk analysis of marine structures in severe meteocean conditions, by taking into account extreme waves during sea storms; this analysis will include the study of the action of extreme waves (freak waves) on the OWC wave energy converters;

- data processing from experimental activities with physical modeling of Oscillating Water Column systems, on fixed and floating structures. These data are available at NOEL laboratory.

Both Monte Carlo approaches and experimental data will be used for the analysis of the dynamic response.

The hydrodynamic analysis will be conducted in the context of the potential theory for an irrotational flow with a free surface (to determine excitation forces, added mass and radiated damping).

Research team and environment

The research team operates at the NOEL (Natural Ocean Engineering Laboratory): a laboratory established within UNIRC. It is composed by a highly specialized team working in the field of ocean engineering and marine energy. Actually, the team involves 1 Full Professor, 2 Associated Professor, 3 Researchers, 2 Post-docs and 2 PhD Students. The team has a 30-year experience in conducting field experiments on small-scale models of marine structures and of wave energy harvesters at the NOEL natural basin. This laboratory is a unique environment where experimentalists can pursue tests with the support of sensors, acquisition data center and specialized personnel established permanently in the laboratory infrastructure facing the basin (for details see www.Noel.Unirc.It).

The mission of this group is to utilize the knowledge acquired in the field of marine and civil engineering to develop novel methodologies in the analysis of the wave phenomena and of the wave climate, for wave structure interaction (floating or fixed structures). The group is also involved in the analysis of coastal structures for protection purposes (for instance caisson breakwaters), in the development of novel coastal structures hosting devices for wave energy harvesting, in the development of experimental activities for testing floating offshore wind turbine models, and in the testing of the prototype of an offshore multipurpose platform for fish farming and exploitation of wind and wave energy (Horizon 2020 project The Blue Growth Farm 774426).

Suggested skills for this research topic

Fluid mechanics

Wave mechanics

Random process theory

Dynamics of structures

Numerical analysis

Physical modelling

Algorithm coding (Fortran, Matlab, Python, etc.)

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.03

Curriculum: 3. Technology and Territory

Development of nanostructured electrolytic materials for more sustainable batteries

Reference Person: Bordiga Silvia (silvia.bordiga@unito.it)

Host University/Institute: University of Torino

Research Keywords:	Solid-state battery Inorganic synthesis Physico-chemical characterization
Reference ERCs:	PE4_8 PE5_6 PE3_4
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Digital transition cannot take place without a great improvement in the technology for electricity management, in order to deeply exploit alternative energy sources and accounting for the growing demand of power. In this scenario, devices for energy storage and transfer (such as rechargeable batteries) are destined to play a predominant role, requesting more and more efforts for their optimization. As a matter of fact, even a modest increase in process efficiency is likely to result into huge environmental and economic benefits, because of their widespread application.

In particular, conventional batteries atone for the use of liquid electrolytes, typically based on flammable and toxic organic solvents, posing serious limits in terms of stability and user safety. Moreover, the introduction at the end of last century of lithium as an energy vector (recently awarded with the Nobel prize), despite having greatly increased the batteries efficiency, has led to an unexpectedly high consumption of that metal, arising some concerns about its future availability and the long-term sustainability of this technology (especially considering the so far inefficient recycling strategies).

Therefore, the research for innovative materials, whose large-scale production would be more affordable and economical, that can anyhow compete with the state-of-the-art batteries, is indispensable and cannot be postponed.

In the last decades, the biggest breakthrough in that sense has been represented by the development of solid-state batteries, where the two electrodes are connected by a solid electrolyte. Despite the great interest of the scientific community on this topic, there is still space for innovation, either by optimizing the materials already proposed for this application or by designing new ones. Such materials are mostly ceramics, where the electronic properties are determined by the redox behavior of inserted heteroatoms, the crystalline structure and the morphology of the particles.

The aim of the PhD project is the development of new inorganic solid-state electrolytes, prepared through the most common protocols of chemical synthesis (including sol-gel and solvothermal processes, chemical vapor deposition, and electrospinning), then testing them into electrochemical application to evaluate the conductivity, the potential range of stability and the cyclability in time of the charge/discharge process.

Afterwards, the most promising materials will be deeply investigated by advanced spectroscopic methods to correlate the high performances with specific structural features at a molecular level, so that some fundamental guidelines can be extrapolated and generalized.

Finally, it is worth noticing that also the synthesis itself of these materials can arise some concerns, especially because of the chemicals used as solvents and additives. Therefore, once a material (or a class of materials) will be selected, some ecofriendly solutions will be explored for the preparation, always evaluating the overall costs-profits balance of the process. For instance, it has been already demonstrated that in many cases the traditional volatile organic solvents can be effectively replaced by less expensive, easily accessible, and non-toxic deep eutectic solvents.

Research team and environment

The PhD project will develop in the frame of a collaboration between the Group of Physical Chemistry at the University of Torino and the Group for Applied Materials and Electrochemistry at the Polytechnic University of Torino (in the person of professor Claudio Gerbaldi).

The former Group has a renowned experience in the synthesis of inorganic and metalorganic materials and their characterization through spectroscopic, microscopic and diffractometric methods, whereas the latter Group is expert in the development of innovative electrolytes and their application into ecofriendly energy storage and conversion devices (as respectively testified by the above uploaded publications and funded projects).

Both Groups are well equipped for the manipulation of air-sensitive samples, through the use of glove-boxes and Schlenk lines, together with custom experimental setups for characterizing the samples in operando conditions and for testing them in commercial-like applications. Furthermore, some experiments at international large-scale facilities (such as synchrotrons and neutron sources) are prospected, upon submission of specific proposal, thanks to the long-standing experience of both Groups in these activities.

More in general, all the national and international ongoing collaborations with other academic institutes and Companies will provide the PhD student with a very dynamic environment, offering several possibilities for his/her mobility and keeping him/her in constant touch with the needs of the modern society.

Finally, the geographical proximity of the two Institutes constitutes a not negligible advantage, promoting a strong and frequent connection between the two units, thus overcoming the difficulties in the communication among the two different sectors.

Suggested skills for this research topic

The PhD candidate can be a chemist, a material scientist or a chemical engineer, he/she should have a solid knowledge of electrochemical fundamentals and processes, and good skills in chemical synthesis and in computational data processing. Most important, he/she should be well disposed towards discussion and team works.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.04

Curriculum: 3. Technology and Territory

Highly emissive materials for energy-efficient devices, photovoltaic and photocatalytic systems

Reference Person: Brenna Stefano (stefano.brenna@uninsubria.it)

Host University/Institute: University of Insubria

Research Keywords:	Emissive materials Energy-efficient devices Photovoltaic and photocatalytic systems
Reference ERCs:	PE5_9 Coordination chemistry PE5_6 New materials: oxides, alloys, composite, organic-inorganic hybrid, nanoparticles PE4_15 Photochemistry
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

A promising approach to reduce energy consumption relies on the fabrication of new materials devoted to energy efficiency, especially those which exploit the interaction with light in their performances. In view of this, the search for highly emissive materials is a major objective for chemists and material scientists since they represent a key target for many lighting applications. An example of these devices are organic light-emitting diodes (OLEDs) which use red, green, and blue emitters, with the latter covering about 50% of the total pixel area of the display. While great success has been achieved in the fabrication of red and green phosphorescent OLEDs (Ph-OLEDs), many efforts are still devoted to developing a proper blue counterpart. The main objective of this PhD project is thus the search of new emissive materials to be implemented in energy-efficient devices (i.E., OLEDs) in photovoltaic or photocatalytic systems. The work will configure as a continuation of a PhD project conducted in a previous cycle, focused on the synthesis of blue emissive materials based on imidazo[1,5-a]pyridines, an interesting class of dyes characterized by large Stokes shifts, good photostability and high quantum yields. The PhD candidate will implement this class of compounds and will design and prepare new functional materials with better performances. The work will first focus on the synthesis and full characterization of the compounds, both in solution and in the solid state, to achieve information on the molecular structure of these species. The optical properties of these materials will then be thoroughly investigated in

solution, in the solid state and as thin layers when dispersed in a host polymeric matrix. Thanks to the collaboration with Prof. Klaus Meerholz, Chair for Organic Electronics Group at University of Cologne, the most promising compounds will be integrated into OLED devices and tested for their efficiency. Structure-properties relationships will be established by combining experimental data and theoretical approaches. In particular, the results obtained from DFT calculations will reveal crucial in directing the design of new molecules to be implemented in better performing materials.

Research team and environment

The research project will be conducted at the Inorganic and Organometallic Chemistry Labs of the Department of Science and High Technology, University of Insubria. The PhD candidate will operate in fully equipped labs for advanced inorganic and organometallic chemistry synthesis. He/she will have direct access to a complete list of instrumentation needed for the spectroscopic characterization of the samples (FT-IR, NMR, HPLC LC-MS, ICP-MS, GC-MS, TGA/DSC). The labs are also equipped with different UV-vis spectrophotometers and steady state and time-resolved fluorimeters, which will allow full investigation of the photophysical properties of the emissive materials, both in solution and at solid state. Additional equipment for electrochemical measurements, variable-temperature photoluminescence studies, spin coating, photocatalytic reactors are also available.

The daily work will be supervised by the reference person, with the support of all the research team, in particular Prof. Attilio Ardizzoia (expertise in synthesis and DFT calculations) and other PhDs and/or PostDocs. The established international collaborations with Prof. Bruno Therrien (University of Neuchatel, X-ray diffraction), Prof. Julien Furrer (University of Bern, advanced multinuclear NMR experiments) and Prof. Klaus Meerholz (University of Cologne, device fabrication) will allow the applicant to interact with chemists and materials scientists with multidisciplinary expertise.

Suggested skills for this research topic

A Master Degree in Chemistry is required to apply for this position. Advanced scientific and technical knowledge in all disciplines of chemistry, materials science, catalysis. Strong expertise and previous experience in inorganic and organometallic synthesis, characterization of inorganic and coordination compounds and spectroscopic examination of their reactivity are advisable. Expertise in organic synthesis will also constitute a plus. Transferable skills: research skills from fundamental to applied, critical approach to problems, capability of autonomous operations; effective time management and organizational skills to meet the deadlines; good communication skills, also in an international context.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

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SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU3.05

Curriculum: 3. Technology and Territory

Nonlinear technologies for green energy control

Reference Person: Buscarino Arturo (arturo.buscarino@unict.it)

Host University/Institute: University of Catania

Research Keywords:	Sensors Networks Green energy optimization
Reference ERCs:	PE7_1 PE7_12 PE7_11
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

The research topic focuses on the optimal management of energy from renewable sources. The topic will cover the optimal distribution of the energy in a network as well as the use of innovative sensors and technologies to guarantee the optimal quality of the electrical power parameters, such as voltage and frequency. The main aspect of the research will hinge on the use of nonlinear technologies, and, in particular, nonlinear dynamical behavior of the components of the network, in order to enhance the energy scheduling allowing the just-in-time production and distribution of energy among more nodes (users). This is conceived by using a strategy that is controlled by chaotic signals. In fact, it has been recently proved by the reference person for a limited number of nodes that this strategy is effective. The aim is to generalize these results for a complex integrated green network with extended number of users. Moreover, each user should be guaranteed that the main parameters of the electrical quantities are effectively controlled and supervised. This will concern the second part of the research, where it will be considered a novel class of sensors based on the concept of nonlinear resonance behavior of peculiar devices able to detect the frequency drifts. Therefore, a network of such devices that can also be digitally implemented and installed in a platform based on recycled smartphones.

The main guidelines that the PhD programme will cover consists in improving the integration of renewable energy sources to conceive new control strategies and low-cost and green sensors achieving a complete optimization of the energy distribution systems. The tasks of

the research will lead also to consider the previously introduced aspects to improve the efficiency of networks devoted for power supply of recharge stations for electrical cars.

The research is, therefore, organized in the following tasks:

1. To consider green energy plants integrated in classical electrical networks, such as a complex system.

2. To adopt innovative strategies based on nonlinear technologies in order to optimize such networks, by using low-cost and green devices.

3. To use the product of the research in order to improve the quality of life in cities as regards the improvement of the local electrical networks used for sustainable mobility.

The PhD programme is therefore organized to allow the candidate, starting from the innovative results obtained by the reference person in the mentioned area, to develop the tools that can be made available to the Institutions in order to improve the quality of the environment. One of the educational aims of this project is spreading the idea that both nonlinear systems and imperfect systems, if well studied, can lead to an improvement in the global behavior of the considered networks.

Products of the research will be:

1. New control paradigms;

2. Development of green sensors and smart networks eliciting a circular economy;

3. Development of strategies devoted to transfer this knowledge not only in the area of sustainable electrical networks but also in the more general framework of networked systems.

Research team and environment

The research team consists in professors from the Dipartimento di Ingegneria Elettrica e Elettronica of the University of Catania, people involved in the Istituto Nazionale di Geofisica e Vulcanologia of Catania and from STMicroelectronics. Therefore, the various labs of the three institutions will cooperate during the PhD. Moreover, the research team will be supported by the facilities of the National Research Council (CNR) – Institute of Systems Analysis and Computer Science "A. Ruberti" and the ENEA – Frascati nuclear fusion labs. The research activities will be also developed with the involvement of the research labs at the TU Eindhoven (The Netherlands) and at the University of Cambridge (United Kingdom). The international support of the PhD project will be given by the University of Wisconsin – Madison (USA) and from MediaTek (USA).

For this scholarship it is planned a period of internship at *Istituto Nazionale di Geofisica e Vulcanologia - Sezione di Catania*

Suggested skills for this research topic

Master degree in the area of Industrial, Electrical, Electronics or Computer Science Engineering.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.06

Curriculum: 3. Technology and Territory

Smart zero-carbon buildings and digital twins

Reference Person: Casini Marco (marco.casini@uniroma1.it)

Host University/Institute: Sapienza University of Rome

Research Keywords:	Energy efficiency of buildings Smart buildings Digital building twins
Reference ERCs:	PE6_7 Artificial intelligence, intelligent systems, multi agent systems PE7_3 Simulation engineering and modelling PE8_3 Civil engineering, maritime/hydraulic engineering, geotechnics, waste treatment
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Reducing carbon emissions of buildings will be critical to achieve the Glasgow climate goals and reach net zero emissions targets by 2050. It is therefore urgent for all countries to focus on how to make buildings more energy-efficient, less carbon-intensive over their full life cycle, and more sustainable.

In this picture, the integration of digital technologies in buildings can be a cost-effective solution to enable healthier and more comfortable spaces with a lower energy use and carbon impact and can also facilitate the integration of renewable energy sources in future energy systems. The ultimate goal is to achieve smart energy buildings perfectly integrated into their environment, connected to the global network and able to receive, process and take advantage of data and information to communicate with their users and share their infrastructure with that of the city and the transport systems, acting as funding elements for a wider, highly efficient urban system, delivering better quality services for citizens and accompanying benefits such as local job creation, health, and well-being. With the increasing diffusion of BIM and IoT devices, the future of both building operation and maintenance is represented by the digital twin technology, which promises to revolutionize the way buildings are managed and maintained by transforming them into a rich ecosystem of data and insights provided by AI.

Research activities shall focus on developing and testing new models, more efficient, secure and affordable technology and systems with in-built intelligence, to allow real-time smart management for new and existing buildings and districts and foster mass take-up of energy efficiency and energy saving solutions for the transition towards a net-zero carbon and circular built environment. Integration of renewable energies, electric storage, demand response and V2B technologies will be investigated, along with smart grids, smart meters, and microgrids, also considering the role of green hydrogen in decarbonization of buildings. Particular attention will be given to the new, AI-empowered advanced building control strategies based on Model Predictive Control (MPC) and Machine Learning. Applications of Digital Twin, Extended Reality (VR, AR and MR) and Robotic technology in building operation and maintenance will be also studied, evaluating the advantages in supporting management tasks and strategic decision making, along with the new tools such as building renovation passport (BRP) and digital building logbooks (DBL) to promote the buildings as material banks (BAMB) concept and the circularity of materials in construction.

The results of this investigation are expected to provide valuable insights on how digitalization and innovative technologies and systems can transform the way that infrastructure, real estate and other built assets can be operated and maintained in order to provide a more comfortable, energy efficient, sustainable, cost-effective and smart built environment.

Research team and environment

The research team is composed by an interdisciplinary group with extensive collaborative academic and industrial networks in Italy, Europe and globally, which includes, in addition to the reference person Prof. Marco Casini, the professors Livio De Santoli, Carlo Rondinini, Maurizio Barbieri, Fausto Manes, Angelo Lalli, Mariella Nocenzi, and Maurizio Muscaritoli, all members of the ""Sapienza Scientific-Technical Commitee on Sustainability"".

The research activities will be carried out in an integrated environment within the Department of Urban Planning, Design and Technology of Architecture (PDTA), of Department of Aerospace, Electrical and Energy engineering (DIAEE), and of Department Computer, Control, and Management Engineering (DIAG) and the Interdepartmental Research Center for Territory Buildings, Environment and Restoration (CITERA), of Sapienza University.

Suggested skills for this research topic

In order to perform successful research, a master's degree in a technical-scientific area is needed (Civil, Building, Environmental or IT engineering). Ideally, the successful candidate should be able to work in a multidisciplinary team and an international context and have a basic knowledge of:

- Energy efficiency in buildings, renewable energy resources, building automation systems, smart grids, Building facility management, Digital Building Twin

- Building information modelling and computational design
- Building performance simulations tools (EnergyPlus, Modelica, LCA tools, etc.)
- Programming tools such as matlab/simulink/plecs/C sharp/python
- Big data analytics and artificial intelligence techniques (neural networks, machine learning, etc.)

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

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SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU3.07

Curriculum: 3. Technology and Territory

Assessing green infrastructures' mitigation effects by geo-data and simulation

Reference Person: Causone Francesco (francesco.causone@polimi.it)

Host University/Institute: Politecnico Di Milano

Research Keywords:	Green infrastructure
	Numerical modelling
	Geo-reference data analysis
Reference ERCs:	PE8_3
	PE8_6
	PE8_11
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Green infrastructures are often proposed as nature-based solutions viable to provide wide ecosystem services, including extreme-climate effects mitigation, especially in urban environments. However, the scientific literature lacks of quantitative information about the potential climatic effects of green infrastructures, differentiating between size, density, and typology of vegetation. Designers, thus, lack of both benchmarks and tools to design and assess potential benefits of new urban green infrastructures, to mitigate, for example, urban heat island (UHI) effects. The proposed research aims at bridging this knowledge gap by combining geo-referenced data (e.g., via Copernicus database) together with ground thermo-physical measurements, to validate numerical models (typically CFD models or hybrid multi-physics models), describing the green infrastructure. The activities will be both experimental, by using an already developed (by the host institution) wireless instrumentation, dedicated to measure all the useful thermo-physical parameters necessary to assess the outdoor climate conditions (with high time resolution), and numerical, by both investigating and using geo-data (with high space resolution) and developing numerical models (e.g., CFD models). After an adequate literature review, foreseen to both evaluated all the available database and techniques that might be used for the purpose of the work, the candidate will establish a clear methodology, that will include: (i) database investigation and data gathering; (ii) data processing; (iii) data analysis; (iv) numerical model development; (v) validation; (vi) case study application. The expected outcomes are: (i) a validated methodology to quantitatively assess the climate benefits provided by green infrastructure

to the urban environment; (ii) a tool to support designers in the performance-based design of green infrastructures; (iii) a case study, to be agreed upon by parties, analysing how different greening scenarios influence the outdoor climate conditions under different (present and future) climate scenarios (estimated using different emissions scenarios, i.e., RCP 4.5 – 8.5). The candidate will improve his/her knowledge in urban physics, including heat and mass transfer, applied thermodynamic and energy modelling of buildings and green infrastructures. He/she will furthermore gain modelling skills and critical knowledge on the usage of dynamic simulation tools (e.g., CFD), he/she will substantially improve his/her skills on data analysis and investigation of geo-data and eventually he/she will gain experience on thermo-physical measurements in field. These multidisciplinary skills will represent a huge advantage for future careers both in research and in design, furthermore they will help establishing a unique mind-set for decision makers on climate change related topics.

Research team and environment

The Buildings' Environment and Energy Systems (BEES) research group is made of 1 full professor, 4 associate professors, several post-doc fellows and Ph.D. students, all active at the Energy Department of the Politecnico di Milano. The team has a good experience on both energy and CFD analysis of single buildings and urban assemblies and its already supervising M.Sc. and Ph.D. thesis projects on related topics. The team was involved in a 2-years research project, funded by ENEA, for the development of an experimental technique to assess outdoor climate conditions in urban environments and within this framework it developed a dedicated experimental station to measure all the useful thermo-physical parameters necessary to assess the outdoor climate conditions with high time resolution. The research group is also part of the GEOLab at Politecnico di Milano, that involves several departments interested and active on the use of geo-data for different research purposes. The Lab is part of the wider Copernicus Academy Network.

The team is active in 2 EU funded research projects (Sharing Cities and NRG2peers) and is PI of a recently funded PRIN projects (URBEM), all about the modelling of complex urban environments for the creation of smart city services, including energy communities. Within the framework of these projects a substantial expertise on energy and environmental data analysis has been developed, including large database analysis via machine learning techniques.

The team also provides industrial consultancy activities, and won as Environmental Expert of the Co-inventing Doria project, the first edition of Reinventing cities contest, for the design of carbon-neutral communities.

For this scholarship it is planned a period of internship at *Comune di Milano, Milano*

Suggested skills for this research topic

The candidate needs to have knowledge and skills on heat transfer and CFD modelling. Some experience with ANSYS Fluent and/or OpenFOAM is welcome. He/she needs to have some skills in data analysis, such as clustering analysis, database investigation. Some

knowledge in coding is welcome (e.g., Python, C++, R, Matlab, etc.). Attitude and interest toward sustainability and urban related climate change effects is essential.

Fluency in Italian is required, due to the tight collaboration with the technicians at the Municipality of Milan, further than fluency in English.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.08

Curriculum: 3. Technology and Territory

Photoelectrocatalytic conversion of CO2 for sustainable and resilient energy management

Reference Person: Centi Gabriele (centi@unime.it)

Host University/Institute: Università degli Studi di Messina

Research Keywords:	CO2
	Solar fuels
	Smart energy management
Reference ERCs:	PE4_10
	PE4_12
	PE4_4
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The thesis has the objective to develop integrated competencies for the organization and strategic direction in public administrations of the renewable energy value chain. The Doctorate aims to develop, by using a specific case example on which focus the study, knowledge, and competencies for:

1. Participation in the organization and strategic direction of public administrations (local, regional, national) to develop innovative strategies for the renewable energy value chain

2. Develop research paths to valorize management competencies, leadership, and communication skills for public organizations, including in the human resources area, in reference to the renewable energy sector

3. Reinforcement of the administration capabilities to develop public politics and decision, implementation, and evaluation tools in the energy sector.

The specific case example around which are built above competencies is a key technology to accelerate the transition to the replacement of fossil fuels and close the carbon cycle: the development of devices called artificial leaves to produce solar fuels in a distributed approach capable of integrating more effectively with the territory and its resources, enhancing its resilience, and with a direct boosted contribution to reduce the emissions of CO2 (both reusing this molecule and using solar energy for its conversion) and the territory impact on climate changes.

This objective requires a holistic system approach, which integrates fundamental knowledge of applied, engineering and industrial, and socio-economic aspects. The proposed research integrates fundamental studies on materials and mechanistic aspects, with the technological and engineering development of the devices, with analysis also of socio-economic aspects related to the use of these devices and their impact on the mitigation of CC and the replacement of fossil fuels.

The aim is thus to provide, by investigating the development of a specific critical technology, integrated by the additional competences and educational activities given both at the local and national level through the National Doctorate, both the technological and additional skills which allow promoting the human capabilities for proper management and strategic direction of the relevant area of sustainable energy.

The study will address the development of artificial leaves to produce solar fuels to be used for local renewable energy chains, a priority indicated in recent national priorities to promote the sustainability of regions in the south of Italy. Specifically, the aim is a decentralized production/storage to boost the transition to "intelligent" forms of energy generation and distribution.

Artificial leaves are devices that use solar energy to convert molecules such as H2O, CO2, and N2 (widely available) into solar fuels (H2, methanol, NH3, respectively), acting as chemical energy storage molecules for transport and distributed use of renewable energy (solar) replacing the need of fossil fuels, therefore drastically reducing greenhouse gas emissions, with an enhancement of local renewable energy resources, overcoming the limits associated with fluctuations in demand and load imbalances in the renewable energy production.

Research team and environment

The research team where the PhD student will operate is composed of two full professors, four associate professors, three researchers, and about 15-20 PhD/post-docs on aspects related to the development of sustainable processes for chemistry and energy (are industrial chemistry and engineering), with an interdisciplinary approach combining chemistry, material science, engineering, and physics.

The research team has many running international EU projects, including an ERC Synergy, and well established international (worldwide) collaborations and networks with research centers and companies in the area of catalysis for clean energy and CO2 conversion, sustainable processes, and technologies beyond fossil fuels.

The students will operate at the CASPE center (Laboratory of Catalysis for Sustainable Production and Energy) of the University of Messina (and reference center for the InterUniversity Consortium INSTM on science and technology of materials, which has spaces and advanced equipment (ww2.Unime.It/catalysis) suitable for carrying out the planned research.

The spaces available to the CASPE center, following the recent renovation, are approximately 550 m2 (in five modules, two of which are dedicated to laboratory systems for catalytic testing (including photo and electrocatalytic systems), three for the instrumental characterization of catalysts, and their synthesis. The research will deal with the development (synthesis, characterization, and testing) of the nanomaterials/electrodes for the artificial leaf device, their study, and engineering, and the assessment of the technology. PhD students will typically operate in close collaboration with other early-stage researchers, under direct supervision by one or more experienced researchers, and one professor.

Suggested skills for this research topic

Scientific/technical knowledge on: chemistry, material science, industrial chemistry and catalysis, engineering of devices, characterization of solids, testing of photo/electro materials, analysis of the mechanisms of solarinduced processes in nanomaterials, assessment methodologies.

Transferable skills: team working in an international context, a problem-solver approach and critical thinking, research skills from fundamental to applied and industrial, capability of autonomous operations and leadership, managing and report in international projects, communication skills.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.09

Curriculum: 3. Technology and Territory

Biochar for Carbon Capture and Sequestration and accounting

Reference Person: Chiaramonti David (david.chiaramonti@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Biochar as a tool for carbon sequestration Long term carbon fixation in the soils Carbon offsets accounting in agricultural land
Reference ERCs:	PE10_3: climatology and climate change PE8_11 Environmental engineering, e.G. Sustainable design, waste and water treatment, recycling, regeneration or recovery of compounds, carbon capture & storage SH1_12: Environmental economics; resource and energy economics; agricultural economics
Reference SDGs:	GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

This research project will contribute to the development and upscaling of a versatile and efficient negative emission technology for decarbonisation: biochar. The project aims at optimizing the carbon sequestration potential offered by biochar production, map its applications in the agricultural sector and improve the accounting of its emission offsetting potential.

The use of biochar, a carbon-rich material produced from the pyrolysis of biomass, allows for creating a stable carbon sink. The resulting "Recalcitrant Carbon" can remain in a stable form for decades, being a real, reliable carbon sink. This approach of Bio-Carbon Capture and Sequestration (BioCCS) that uses biochar as a soil amending material offers the further advantage of being easily verifiable and measured.

However, to date, the use of biochar for emission offsetting is still in its infancy, despite its highly promising features, due to the need for further technological testing and advancements, and because of a lack of a clear framework to transparently account for its use.

The planned activities for the PhD research encompass experimentations and analysis at a pilot level, for the production of biochar. The production of biochar can rely on different advanced feedstock, for instance recovering the organic fraction of wastes, or other organic

materials and/or residual lignocellulosic streams. Different feedstock will be tested in the project, and the resulting product characterized for possible applications.

The research will also address existing and innovative methodologies for the generation and accounting of carbon credits, starting from a review of existing practices. Currently, the process of certifying emission offsets as stable carbon in the soil in the form of biochar is not clearly articulated in any legislative framework. Country governments and companies are highly interested in this application to achieve their decarbonization commitments, but for now the accounting of emission reductions through this pathway remains ambiguous. The project will develop new methods of accounting for emissions in production, distribution and consumption activities and models of knowledge, measurement and monitoring of the effectiveness of the actions. The research will be of paramount importance to create a sound scientific background for adopting biochar as a negative emission technology at the policy and legislative level, as well as for corporate use.

Overall, the research will contribute to the definition of actions to mitigate the impacts of climate change and to promote of sustainable development, as a contribution to the green recovery and to overcoming the effects of the crisis in the context of the COVID-19 pandemic. The research is in line with the provisions of the National Research Program, in the field of research and innovation ""Climate, energy and sustainable mobility"", and will provide concrete instruments to create a more resilient and circular economy.

Research team and environment

The study requires an interdisciplinary approach and thus the PhD student will need to be supported by a diverse team. The current group collaborating with Prof. Chiarmonti encompasses all the required skills, with internationally recognized experts on thermochemical conversion processes, catalyst development, bioenergy and sustainability analysis. Currently the group consists of a senior researcher, 3 PhD students and works in strong collaboration with the Chemistry Dept. Of POLITO.

Prof. Chiaramonti is also president of the no-profit research body RE-CORD, which owns several unique pilot-scale reactors, a chemical lab fully dedicated to bioenergy and a group of experts.

Moreover, the existing collaboration with the socio-economic experts' group led by Prof. Cambini will effectively complement the existing skillset, offering to the PhD student a wide and simulating environment, in which to develop his/her researcher.

Suggested skills for this research topic

The ideal candidate should:

- have to a sufficient background on renewable energy technologies, and specifically on thermochemical biomass conversion;

- have a sufficient background on the environmental impact of energy production and use,
- be knowledgeable specifically about GHG emissions, with a clear vision of the main on-going actions for promoting economy-wide decarbonization, both at the country and EU level;
- be highly proactive and able to work autonomously;
- have good personal/relation skills and be keen to work in team;
- show a strong motivation in working on the topic and performing research activities.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU3.10

Curriculum: 3. Technology and Territory

Sustainable manufacturing and smartness

Reference Person: Dassisti Michele (michele.dassisti@poliba.it)

Host University/Institute: POlytecnical University of Bari

Research Keywords: Sustaibable manufacturing
Smart manufacturing
Industry 4.0

Reference ERCs: PE8_9
PE8_11
PE8_8

Reference SDGs: GOAL 12: Responsible Consumption and Production

Description of the research topic

Manufacturing organizations are facing the urge to adopt new strategies like sustainability to be able to respond to the market and customer's demand for sustainable products due to the scarcity of the natural resources or government policies. To serve this purpose, several approaches have been explored so far, from optimisation strategies up to smart manufacturing. Provided there is not still a clear view or even a solution so far to this big issue.

Research team and environment

Michele DAssisti - full professor

Fulvio Lavecchia - associate professor

Dr. Ing. Concetta Semeraro - Sharjah University (cooperation)

Suggested skills for this research topic

Manufacturing technologies

Engineering

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.11

Curriculum: 3. Technology and Territory

Circular economy as a driver for territorial development

Reference Person: De Chiara Alessandra (adechiara@unior.it)

Host University/Institute: University of Naples L'Orientale

Research Keywords:	Circular economy Sustainability innovation Green transition for territorial development
Reference ERCs:	SH1_10 Management; strategy; organisational behaviour SH1_3 Development economics; structural change; political economy of development
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production

Description of the research topic

The research proposes the green transition and the development of circular economy initiatives as a driving force for territorial development.

The industrial symbiosis and social capital frameworks represent the theoretical basis for the investigation of the territorial development that starts from the support for circular economy initiatives that, from the very specificities of the territories - resources and industrial culture - can identify opportunities for business (in particular for micro-enterprises operating on the national territory) and play the role of a multiplier for the birth of an economic system that adopts the principles of "closing the circle".

The identification of the drivers of circular entrepreneurship, the identification of local specificities and the rediscovery of shared values between the socio-economic and institutional subjects, can guide policies in supporting the development of circular economy initiatives, enhancing, thanks to solid networks of relationships, the local specificities and creating new opportunities for economic and social growth. Therefore the research will have theoretical, managerial and policy implications.

The research will be carried on with the support of external partner both research partners - as universities and other research centers - and business partners - as organizations involved in circular economy initiatives the will bring know-how and expertise suitable for identifying new sustainable supply chains, within and outside the national territory, and to outline new

horizons for territorial development. In addition, the research partners can contribute to the identification of best practices.

Research team and environment

The research team includes the phd student who will interact with researchers, within the doctoral college and the university partner, and actors belonging to the local system.

The research project will create a network of researchers in order to study and individuate the theoretical background, enhancing the green research themes within the doctoral studies.

The research project will enable a network of actors to implement circular business and system models and will favor the development of relations within the institutional environment in order to plan and implement policies for green transition for territorial development.

For this scholarship it is planned a period of internship at *Lavandula, Castelcivita (SA)*

Suggested skills for this research topic

The candidate must be in possession of a master's degree or a suitable qualification obtained abroad.

In the selection of the candidate will be taking into account specific comptences on sustainable development and sustainable innovation in companies.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.12

Curriculum: 3. Technology and Territory

Innovative power cycles and working fluids for the energy transition

Reference Person: Di Marcoberardino Gioele (gioele.dimarcoberardino@unibs.it)

Host University/Institute: Università degli Studi di Brescia

Research Keywords:	Closed thermodynamic cycles
	Renewable energy conversion and biofuels production from renewable energies
	Thermodynamic and transport properties of fluids
Reference ERCs:	PE8_6 Energy processes engineering
	PE8_2 Chemical engineering, technical chemistry
	PE11_2 Engineering of metals and alloys
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 9: Industry, Innovation and Infrastructure

Description of the research topic

Nowadays, the energy scenario is rapidly evolving towards new and efficient methodologies for the conversion of "primary" renewable energy sources into mechanical energy, electricity and thermal/refrigeration energy, a decisive role is played by heat engines that adopt different working fluids or mixtures, operating in closed thermodynamic cycles, such as the Rankine cycle or the Joule-Brayton cycle.

As a matter of fact, closed thermodynamic cycles can convert heat from any source (waste heat from industrial processes, renewable sources, nuclear, etc.): they can therefore be adapted to different and varied applications exploring different configurations to solve design and optimisation issues.

For example, (1) recoverable heat from industrial processes is not always continuously available; (2) the widespread use of renewable energy sources (also with systems of very different power sizes) requires the development of flexible, remotely controllable systems, in general with the integration of a storage system for the produced excess energy.

Within this framework, the proposed research concerns the development and study of efficient, versatile, flexible and economically sustainable systems to convert renewable energy sources into their possible final use (i.E. Electricity, heat etc.) as well as into decarbonised energy carries such as hydrogen and biofuels.

The use of innovative thermodynamic cycles (with innovative working fluids and configurations) also involves the necessity to identify the most effective working fluids or mixtures for any specific application, in consideration of the relevant thermodynamic properties, and their thermal stability limit (the maximum temperature at which the fluid can operate), which is general evaluated experimentally. Additional experimental analysis are required to assess the compatibility between different materials and working fluids, aiming at identifying the most cost-effective materials to adopt, particularly in the high temperature sections of the power cycle. Finally, the study of the performance and the design of key components (heat exchangers, turbomachinery, electrolysers) is also based on the theoretical and experimental evaluation of the thermodynamic transport properties (i.E. Thermal conductivity and viscosity) of the working fluid.

The objectives mentioned above are demanding from both a technical and scientific point of view and certainly relevant for a Phd course that aims at providing a concrete contribution to the knowledge in the context of the energy transition.

Research team and environment

The support to the research activities will be provided by the Energy Technology Group (ERGO), in the Department of Mechanical and Industrial Engineering.

ERGO's main research activities focuses on the study, analysis, and design of components involved in all the aspects of energy conversion, particularly in case of power plant operating with non-conventional working fluids (ORCs, closed gas cycles, Stirling engines). The main experimental activity of the Group is the assessment of the thermal stability of working fluids for closed cycle engines. This task is carried out in the Fluid Test Laboratory.

The research team, is presently composed by (permanent personnel):

- Paolo Iora, full professor of "Energy and Environmental Systems"

- Costante Invernizzi, full professor of "Fluid Machinery and Energy Conversion Systems"

- Gioele Di Marcoberardino, senior researcher of "Energy and Environmental Systems"

- Modestino Savoia: technician in the Fluid Test Laboratory.

The group actively collaborates with universities and industries (domestic and foreign) also in the context of some international research projects funded by EU.

Suggested skills for this research topic

The ideal candidate should have a background in mechanical engineering, a solid engineering thermodynamics basis, and a basic knowledge of chemical thermodynamics.

The candidate should have a strong interest in processes modelling by specific software and a good familiarity with programming tool such as Matlab, Fortran or similar. A strong interest in experimental activity, starting from the test bench design, project of experimental measurements and analysis of the results, is desirable.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU3.13

Curriculum: 3. Technology and Territory

Artificial Intelligence for Precision Livestock Farming: Supporting Sustainable Production and Improving Animal Welfare

Reference Person: Distante Damiano (damiano.distante@unitelmasapienza.it)

Host University/Institute: University of Rome UnitelmaSapienza, Italy

Research Keywords: Artificial Intelligence

Precision Livestock Farming

Optimization of natural resource usage, animal welfare improvement and resilience to climate transition, reduction of climate altering agents emission and antibiotics usage in animal husbandry

Reference ERCs: PE6_7

PE6_11

LS9_3

Reference SDGs: GOAL 3: Good Health and Well-being, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The new EU common agricultural policy (CAP) [1] has defined the policies for the climate, the environment and animal welfare, which will apply for the period 2023-2027.

To address societal needs about foods and health, the CAP strategic plan [2] supports actions towards the climate transition, sustainable production, animal welfare and environment.

Specifically, the CAP promotes sustainable agroforestry practices, such as: biological agriculture, integrated production, agro-ecology, agroforestry and precision farming.

Additionally, according to the sustainable development goals of the Agenda 2030 [3], the EU Council also promotes the activities devoted to the general improvement of the animal welfare and to fight the antimicrobial resistance.

Precision livestock farming (PLF) is defined as the individual animal management by continuous real-time monitoring of health, welfare, production/reproduction, and environmental impact [4,5,6]. The use of sensors to collect data on animals' behavior and livestock farming production in PLF has several potentials, including: i) the early detection of

diseases and other animal welfare issues; ii) the improvement of production performances; iii) the optimization of available resources usages; iv) the minimization of environmental impact; and v) the increase of livestock farming societal acceptance.

Moreover, the development of new technological tools (e.G., RFID, ruminal bolus, activometers, thermographic cameras) has provided new and significant opportunities to collect fine phenotypes and improve welfare, productivity and sustainability in the livestock sector.

As a result, it is evident that PLF has a great potential to facilitate sustainable production.

The proposed research project is aimed at applying artificial intelligence (AI) techniques and methodologies to data collected in real PLF scenarios to experimentally support the achievement of PLF objectives and potentials.

Specifically, our research goal is to find the tradeoff between livestock productivity and animal welfare, while (among others): i) reducing the usage of antibiotics on animals and in food production; ii) improving the food quality (security and safety); iii) optimizing the use of resources; and Iv) favoring the adaptation and mitigation to climate change.

Historical and new data collected in PLF systems will be analyzed by means of AI techniques and methodologies, with the aim of developing data analysis and prediction models able to: i) determine the best balance between animal nutrition, emission of climate-altering substances and sustainable production requirements; ii) optimize the ecosystem services provided by sustainable intensive livestock farming; iii) identify animal population most resilient to climate change to be involved in an intra-breeding campaign for genetic improvement.

In this field of research, one of the most difficult challenges is related to the need to combine and analyze heterogeneous data coming from different sensor systems.

We plan to combine and process existing historical time series of precision milk data recording (milking ability: speed and yield), animal activity (movement, feeding behavior, rumination time), precision NIR, enteric methane emissions and environmental recording collected from a population of experimental subjects.

In this research, other phenotypes may also be leveraged, including data on the quality of milk and derived products, such as milk coagulation properties (r, K20, a30, Dairy Aptitude Index), spectroscopic profiles, somatic cell values, temperatures on qualifying points of the animal (i.E. Udder, ocular orbit, abdomen, etc.), biochemical important parameters in the animal welfare assessment, such as urea, beta-Hydroxybutyrate, acetone, etc.

This research project will be articulated along the following research lines:

Design and learning of predictive AI models to be applied on heterogeneous data collected in PLF scenarios to support decisions on actions to take towards the mitigation of climate-altering substances emission while preserving the animal welfare and production performances.

Use of statistical and machine learning features analysis techniques to identify the correlation and tradeoff between the dietary animal administration and the emission of climate-altering substances and impact on production performances.

Conducting experimental research aiming at boosting the performances of the learned models.

Applying effective methodologies for the reconstruction of missing data on time series collected by means of digital agriculture technologies.

Design and development of software systems to support the sensor monitor activities.

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Research team and environment

Research at UnitelmaSapienza (a young online & distance learning University directly linked to Sapienza University of Rome) is carried out in various laboratories, research centers by various research groups.

The Intelligent Information Mining research group (IIM - http://iim.Di.Uniroma1.It) involves researchers from UnitelmaSapienza and Sapienza University of Rome that collaborate in investigating research topics in the following research areas: Machine Learning and Data Mining, Knowledge Based Systems, E-Health and Network medicine, Social Media Analysis and Recommender Systems, Human-Computer Interaction and Web Engineering, E-Learning and Educational Data Mining.

The proposed research will be supervised by

- Prof. Eng. Damiano Distante, PhD (SSD INF/01, ERC: PE6_7, PE6_10, PE6_11), Department of Law and Economics, University of Rome UnitelmaSapienza, Italy, Advisory member of the IIM research group (https://iim.Di.Uniroma1.It)

In collaboration with:

- Prof. Stefano Faralli, PhD, Computer Science Department, Sapienza University of Rome, Italy (s.S.D.:INF/01, ERC: PE6_7, PE6_10, PE6_11), member of the IIM research group;

- Dr. Miriam Iacurto, (SSD AGR/19, ERC: LS9_3), Dr. Roberto Steri (SSD AGR/17, ERC: LS9_3) and Dr. David Meo Zilio (SSD AGR/17, ERC: LS9_3), Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (CREA), Italy (agreement to be established between UnitelmaSapienza and CREA - Centro Zootecnia e Acquacoltura - ZA).

Suggested skills for this research topic

- Knowledge of machine learning and deep learning algorithms and techniques for the supervised and unsupervised learning of predictive models on heterogeneous, sparse and noisy data, including data in the form of time series.

- Programming skills with python and AI suites.

- Experience with DBMS, SQL, NoSQL and Web programming.

- Propensity to team working and interdisciplinary research.

The preferred candidate should also have knowledge of PLF methodologies and technologies.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.14

Curriculum: 3. Technology and Territory

Decarbonisation of industry and cross-sectoral implications on the energy system

Reference Person: Fattori Fabrizio (fabrizio.fattori@polimi.it)

Host University/Institute: Politecnico di Milano

Research Keywords:	Climate change mitigation
	Industry
	Sector coupling
Reference ERCs:	PE8_9 Production technology, process engineering
	PE8_10 Manufacturing engineering and industrial design
	SH7_5 Sustainability sciences, environment and resources
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Industry is a key and critical sector for decarbonisation of the economy. On the one hand, the industrial sector is responsible for an important amount of green-house gases emission; on the other hand, new or different technologies and materials must be mass-produced in order to decarbonise other sectors (e.g. insulation materials, heat pumps, electrolysers, batteries). Industry is in general very much connected to other segments of the energy system, such as transport (e.g. transport of goods), power generation (e.g. industrial combined heat and power plants may produce excess power), space heating (e.g. waste heat may be used in district heating networks). The decarbonisation of industry is thus going to bring in several cross-sectoral implications that must be assessed from a systemic point of view.

Industry is a set of very different subsectors (cement, steel, paper, glass, etc.) with a broad variety of processes and temperatures (cooling, drying, cleaning, firing, etc.) and a different impact in terms of consumptions and emissions (the latter can be both from combustion or from processes). The path towards decarbonisation is thus specific for almost each process in each subsector.

The goal of this doctoral research is improving the knowledge about the possible path for the decarbonisation of industry and understanding the systemic implications of such path. The focus is on the main subsectors and processes within the Italian and European industry, in the near and long term. The research activities should focus first of all on the estimation of

the demand of goods and on its evolution, also considering the political framework (e.g. carbon adjustment mechanism). The second step would deal with the analysis of the possible decarbonisation paths in each of the main subsectors, i.e. the analysis of possible technological (e.g. fuel switch) and non-technological (e.g. circular economy) solutions. The third step would be understanding the most likely or most convenient scenarios and estimating the possible consumption of electricity or other fuels (especially e-fuels) in time and space. Based on the previous three steps, the final part would analyse the possible implications of such scenarios on the energy system, for example in terms of: (i) industrial districts with local e-fuels generation and consumption, and CO2 capture; (ii) industrial combined heat and power generation; (iii) availability of waste heat and (iv) freight transport.

Research team and environment

The activities will be carried out entirely or mostly at the Department of Energy of Politecnico di Milano, in close collaboration with the division of emission projections, integrated modelling and indicators of ISPRA. In particular, the candidate will work within the energy scenarios area of the RELAB group, currently made up of three junior researchers, two PhD candidates and two senior researchers with different backgrounds. The area analyses possible evolution of energy systems over medium to long-term time horizons by using and developing energy system models and hourly simulation tools and by performing data analyses. It studies critical issues such as the integration of large shares of renewables into future energy systems, the role of more efficient technologies and innovative conversion processes, possible developments in end-use electrification and their systemic implications (e.g. electric vehicles, heat pumps). The analyses aim at providing indications on how to achieve national and international strategic targets, such as the reduction of greenhouse gas emissions.

The working group collaborates and interacts with important stakeholders (private actors, research bodies, public institutions) involved in the sustainable energy transition at national level.

Suggested skills for this research topic

The ideal candidate should preferably have a good knowledge of the interrelated dynamics of energy systems and a good knowledge of the industrial sector and its processes. He/she should be familiar with the analysis of literature and datasets to detect relevant information in the field.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.15

Curriculum: 3. Technology and Territory

ABEs for mitigating and contrasting climate change in buildings

Reference Person: Favoino Fabio (fabio.favoino@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Advanced Building Envelope systems
	Building Resiliency
	Energy and Comfort in Buildings
Reference ERCs:	PE8_3
	PE8_6
	PE8_11
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production

Description of the research topic

The trend of global warming of last century (0.56¬∞C to 0.92¬∞C increase between 1906-2005) will be reaching a temperature increase between 1.1¬∞C and 6.4¬∞C for the end of this century (depending on the scenario), compared to the period 1980-1999. This average trend produces an increasing number of local extreme events, such as heat waves, increased bushfire risk, extreme storms etc. Considering all the global and local effects of global warming, whether these are chronic slowly changing climate trends or sudden extreme events, it appears fundamental to understand how this context might impact on the way we design and operate buildings. Particularly on how we can support design decision making of building enclosures that could be able (i) on one side to reduce and mitigate the risks related to climate change scenarios (such as energy poverty, passive survivability, heat and cold stress risks etc.), (ii) while on the other to contrast and positively impact on phenomena that are inducing such risks, like Urban Heat Island effect, carbon emissions etc.

In fact the facade is not only a spatial location separating the outdoor form the indoor environment, but a functional system that ensure the performance and the operation of a building, mediating between a changing external environment and the continuity of operations and performance needed for human health, comfort and activities. In the last decade, innovation in building envelope materials and building envelope systems is presenting unprecedented opportunities to control energy and mass flow between indoor and outdoor environment in a dynamic way. This can overcome the limitations concerned to climate change mitigation of the “energy conservation approach”, which was a necessary initial step towards space heating and cooling reductions, but could mean in the future a less

prepared built environment towards a changing climate. Advanced Building Envelope systems (ABEs) are innovative facade systems providing flexible and efficient energy management solutions by integrating (i) solar energy conversion systems, (ii) decentralized HVAC elements, (iii) materials capable of actively and selectively managing the energy and mass transfer through building envelopes (adaptive or dynamic), including for example thermochromic opaque and transparent materials, electrochromic films, phase change materials etc. These allow to conceive the façade as a "selective filter", so to adapt to everchanging climate, being able to find trade-offs or solutions that are able to minimize at the same time carbon emission / energy use, overheating and overcooling, solar control and urban heat island effect. The aim of the research is to:

(i) develop a quantitative evaluation framework to support decision making for building envelope design and building material development, in the context of climate change, with the aim to mitigate and contrast its effects in the built environment;

(ii) provide a quantitative evaluation of different innovative building envelope technologies in different building use scenarios in the context of climate change;

(iii) select promising ABEs solutions that can be integrated in different climate change / building use scenarios in order to guide and inform policy makers.

Research team and environment

The PhD student will be integrated into a multi-disciplinary building physics research group TEBE at the Department of Energy, of about 50 members, focusing on aspects from energy use and production in buildings and communities, to different aspects of indoor/outdoor environmental quality (thermal, visual, acoustic, indoor air quality). The integration in such an environment will strongly facilitate the candidate in understanding both vertical and horizontal aspects of its PhD project, developing collaborations and providing great opportunity for growth and cross-fertilization. Within this larger group, the PhD student will work on a daily basis in the research unit related to building envelopes.

In the last 10 years the TEBE research group has managed about 20 EU funded projects, the Building Envelope (BE) research unit can claim a specific expertise and know-how on smart and multifunctional façade systems, embedding smart materials, building performance assessment as far as all the aspects related to thermophysics, acoustics and lighting and to energy optimisation in a LCC perspective, are concerned. As a plus, to the guidance and knowledge sharing, the student can benefit from the international academic contacts, industrial contacts and experience on real world application developed by the group in the framework of the several EU and national projects on such topics.

Last but not least, the BE research unit benefit of numerous experimental facilities for materials and building envelope systems properties and performance characterization, as well as outdoor test facilities for real world implementation, enabling models validation and calibration, full scale performance characterization and real world demonstration.

For this scholarship it is planned a period of internship at *EURAC, Bolzano*

Suggested skills for this research topic

The candidate must hold a MSc in an energy engineering, civil engineering, building engineering or architecture. During the BSc and MSc, he/she should have passed different building physics exams (at least two), demonstrating knowledge of basic and advanced building physics and building performance, indoor environmental quality aspects (such as thermal and visual comfort).

The candidate should have proven experience with building performance simulation tools (i.E. Energyplus, Radiance etc.), and with scripting and programming in Python and/or Matlab.

It is highly appreciated experience of experimental work and building physics measurements.

The candidate should have experience with MS Office package (mastering Excel), with CAD and some experience with 3D BIM software (i.E. REVIT).

The candidate should have excellent English language skills, analytical skills, and most importantly curious, independent, and proactive.

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD course). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.16

Curriculum: 3. Technology and Territory

Innovative Catalysis for Sustainable Synthesis of Active Pharmaceutical Ingredient

Reference Person: Fini Francesco (francesco.fini@unimore.it)

Host University/Institute: Università degli Studi di Modena e Reggio Emilia

Research Keywords:	Asymmetric Organocatalysis
	Supramolecular- and photo-catalysis
	Sustainable synthesis of Active Pharmaceutical Ingredients
Reference ERCs:	PE5_13 homogeneous catalysis
	PE5_17 organic chemistry
	PE5_16 supramolecular chemistry
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 9: Industry, Innovation and Infrastructure, GOAL 12: Responsible Consumption and Production

Description of the research topic

Catalysis is recognized as one of the most renowned sustainable methodology in organic synthesis for the production of bioactive molecule. In the last twenty years organocatalysis (small-organic molecule metal-free catalysis) has been defined as the third pillar of catalysis by D.W.C. MacMillan and B. List. The Royal Swedish Academy of Science selected them as Nobel Prize of Chemistry recipients for the great advancement in Science and Society. The academic community start to develop novel modes of activation of substrates and to revisit traditional organic reactions with the new paradigm. Tremendous development in terms of sustainable and green chemistry has been attained, but the industry has been reluctant to apply the novel catalysis to the syntheses of active pharmaceutical ingredients (API). Still, few organocatalytic processes developed by industry have been disclosed, showing that organocatalysis and in general innovative catalysis are the tools of choice for a green and bright future in the field of chemistry and in general for humanity.

The research topic will be focused for the development of innovative catalysis for the synthesis of building block in organic synthesis and medicinal chemistry. The development of sustainable green processes for the synthesis of API or even applying novel methodology for the synthesis of patent-expired active principles (generic) will be on paramount importance to make medication as affordable as possible, eventually changing the pharmaceutical

market. In this regard avoiding the use of expensive and impactful heavy metal, towards small organic molecule from the Natural pool will be the key to move on more renewable resources.

Organocatalyst or photocatalyst could be used individually as green catalyst applied to organic synthesis. Then, a synergistic approach might be taken in consideration where more than one catalytic species activate several reaction partners for the synthesis of the products. In addition, at the edge of organocatalysis lies the supramolecular catalysis, where a small organic molecule self-aggregates into supramolecular structure in an orderly fashion taking the activation of substrates to a level never seen before.

Careful attention will be devoted for the application of innovative catalysis to traditional organic reaction. In this regard multicomponent reactions (MCR) are among the most wanted process: by mixing more than two substrates and reagents the synthesis of complex molecules is achieved without further human intervention, eliminating purification process and energy. Great examples are represented by the Passerini and Ugi reactions, or Mannich and Strecker reactions.

The results obtained will be disseminated at national and international scientific meetings, and published in top-tier international scientific journals. The aim is also to raise public awareness on the importance of research and innovation. Specific training to the researchers engaged in the project to manage social media profiles and to public speaking and dissemination.

Research team and environment

The PhD candidate will be part of a young and growing research group working on innovative catalysis in particular on photo-, supramolecular- and organocatalysis where novel sustainable methodologies are developed with the aim to change the world.

Group members and the candidate will interact with diverse science and be exposed to a multidisciplinary environment; besides participating in international conferences and meetings. They will be encouraged to undertake personal development and professional courses, and to develop soft skills.

The reference person has approximately 30 square meter of lab space at the Department of Life Sciences, Università di Modena e Reggio Emilia. The lab is fully equipped with fume hoods, rotary evaporators, UV lamps and several high vacuum and inert-gas lines for the most challenging organic synthesis procedures. The group has access to 100 square meter common laboratory where are placed an in-house HPLC apparatus for organic and chiral compounds separations with PC interface and Polarimeter for chiral compounds characterization. The lab space can accommodate three to four researchers. The group

members have access to the CIGS (Interdepartmental center for Large Instrumentations), a facility where are placed two NMR spectrometers (400 and 600 MHz) together with Mass Spectrometry analyzers (UHPLC coupled with Q Exactive, Ñ¢ Hybrid Quadrupole-Orbitrap, Ñ¢ Mass Spectrometer, ion Trap LC/MS).

Suggested skills for this research topic

The candidate should be able to teamwork in a multidisciplinary environment, thriving for knowledge and thinking outside of the box. It should have the desire to explore novel chemistry without dogma driving the research towards the expected and the unexpected.

Solid foundation of organic chemistry is of paramount importance, proficiencies in catalysis will be preferred, together with strong communication skills in an international environment.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.17

Curriculum: 3. Technology and Territory

Impact of climate change on the renewable energy sector in Italy

Reference Person: Fosser Giorgia (giorgia.fosser@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Renewable energy Climate change Impacts
Reference ERCs:	PE10_3 PE8_6 SH7_5
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The renewable energy sector is strongly tied with climate since the availability of renewable sources, like hydro, solar and wind power, very much depend on rain, radiation, and wind patterns. In a context of decarbonisation of the energy system, it becomes crucial to determine how the whole sector will be affected by climate change. Changes in cloud cover could impact on a solar panel productivity, while systematic changes in wind pattern could reduce the energy production of a wind farm. Meantime the projected reduction in mean precipitation could reduce considerably the energy produced by a hydroelectric power plant.

Regional climate models (RCMs) are been proven to be an important tool in climate research and often used to drive impact models. However, RCMs tend to overestimate cloud cover while underestimating wind speed and precipitation extremes on current climate, thus reducing the confidence in their projections. In contrast, km-scale models, called Convection-Permitting Models (CPMs), substantially improve, especially at the sub-daily time scale, the representation of both precipitation and wind field thanks to the possibility to switch off the parameterisation of convection and to their substantially higher spatial resolution.

This research topic aims to determine the impact of climate change on the renewable energy sector over the Italian peninsula. In particular, the focus will be on radiation, the wind pattern and speed, cloudiness and precipitation. Climate variables will be extracted from

observational and reanalysis dataset, and from state-of-the-art climate simulations, like RCMs from the CORDEX dataset and CPMs from the CORDEX-FPS CONV initiative, for the historical, near and future climate. The analysis of climate data will provide an assessment of the changes expected to impact the energy sector.

Climate analysis will be then integrated into energy system models developed and used within the A2A group. In particular, the results of climate analysis will the basis of the estimation of the electricity production from renewable sources over the Italian territory in the long-term horizon (next 30-40 years). The main goal will be to identify potential trends of producibility in a spatial-temporal framework and, subsequently, to estimate the tendency of generation volumes of existing and future renewable plants in Italy. The probability of extreme climate events that may statistically limit the producibility of the renewable power assets will also be analyzed. In addition, a geographical analysis aimed to identify and categorize the investment attractiveness of Italian regions/areas may be conducted.

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools for facing the challenges arising from increasing complexity and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity. The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA). The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

A2A is an Italian multiutility active in several fields: generation of electricity from different sources, distribution and sale of electricity and natural gas, district heating, waste collection and treatment, electric mobility, public lighting, water service. The mission of A2A is to increase the life quality of clients, citizens and employees, taking care of next generations and future of the planet. A2A has recently published a 10-years industrial plan based on two main pillars: 1) Energy Transition, aimed at sustaining the decarbonization process by developing the electricity production from renewables, the energy efficiency and the electrification of consumptions; 2) Circular Economy: aimed to promote the protection of the environment by the increase of waste reduction, reutilization and recycling. Key company figures in 2021 follows: 11.5 B, Ç¨ of revenues, 500 M, Ç¨ of EBITDA, 13.300 employees.

The analysis of meteorologic and climatic phenomena is of great importance for A2A, as they directly impact many aspects of the business, especially in electricity generation and consumption, energy trading, distribution grids management and control, investment planning.

For this scholarship it is planned a period of internship at *A2A SpA, Milano*

Suggested skills for this research topic

The ideal candidate should have a strong background in data analysis and statistics (analysis of probability distribution functions, uncertainties, etc.) and be familiar with the management of large datasets. He/she should preferably have knowledge of the energy system and its sectors, as well as its possible interactions with weather and climate.

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD course). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.18

Curriculum: 3. Technology and Territory

The impact of climate change on the future energy system

Reference Person: Gaetani Marco (marco.gaetani@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Climate change impact
	Future energy system
	Availability of energy resources
Reference ERCs:	PE8_6
	SH7_5
	SH7_9
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Climate is a major driver for many dynamics of the energy system: the availability of renewable sources, such as hydro, solar and wind, very much depend on rain, radiation, and wind patterns; demand for space cooling and heating is related to temperatures, among others; the availability of waste biomass from agriculture depends on crop yields; moreover, efficiency of several technologies, e.g. heat pumps, batteries and power networks, varies with temperature. In such a context, analysing the impact of a changing climate on the energy system can be key for planning the path towards the decarbonisation of the energy system. Such planning process is usually based on models of the whole energy system that rely on past trends and correlations in historical climate data series.

This research topic thus deals with the analysis of the implications of climate change on demands, resources and efficiencies, as well as other potentially affected segments of the future energy system. The analysis should provide insights on the impact not only of global aspects of climate change (e.g. higher temperature), but also of compound climate events that could have much worse cumulative implication for the energy sector (e.g. a dry winter followed by a hot summer is likely to lead to high cooling demand and low sources for hydro power plants to cover peak loads). The analysis should also consider the spatial dimension of the problem to properly take into account the energy connections between geographical areas characterised by different present and future climate conditions (e.g. high demand of power in the North bidding zone and high availability of renewable resources in the South

bidding zone). The geographical scope of the analysis focuses on Italy, however the assessment of the implications of the results at the regional and global scale is also encouraged.

The research crosscuts two different fields of knowledge: climate science on the one hand, and the energy system analysis and modelling on the other hand. Climate variables related to the energy sector will be extracted from observational and reanalysis dataset, and state-of-the-art climate model simulations, such as the CORDEX regional climate models and the CORDEX-FPS CONV convection-permitting models, for historical and future climate. The analysis of climate data will provide an assessment of the changes expected to impact the energy system (e.g. heat waves and cold spells occurrence, intense precipitation and droughts as well as compound events). Climate analysis will be then integrated into energy system models developed and used by the RELAB group of Politecnico di Milano. Non-climate related data and assumptions of these models should be set according to national and international policy scenarios (e.g. Integrated National Energy and Climate Plan and Long-term strategy).

Research team and environment

The activities will be carried out mostly in the energy scenarios area of the RELAB group at the Department of Energy of Politecnico di Milano, in close collaboration with the climate scientists of the CARISMA group at IUSS Pavia.

The energy scenarios area analyses the possible evolution of energy systems over medium to long-term time horizons by using and developing energy system models and hourly simulation tools and by performing data analyses. It studies critical issues such as the integration of large shares of renewables into future energy systems, the role of more efficient technologies and innovative conversion processes, possible developments in end-use electrification and their systemic implications (e.G. Electric vehicles, heat pumps). The analyses aim at providing indications on how to achieve national and international strategic targets, such as the reduction of greenhouse gas emissions. The working group collaborates and interacts with important stakeholders (private actors, research bodies, public institutions) involved in the sustainable energy transition at national level.

The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

IUSS and Politecnico di Milano are actively committed towards internationalisation, inclusion and diversity.

Suggested skills for this research topic

The ideal candidate should have a strong background in data analysis and statistics (analysis of probability distribution functions, uncertainties, etc.) and be familiar with the management of large datasets. He/she should preferably have basic knowledge of the energy system and its sectors, as well as its possible interactions with weather and climate.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.19

Curriculum: 3. Technology and Territory

Exploiting nonlinear dynamics for the design of innovative solutions of vibration energy harvesters

Reference Person: Gatti Gianluca (gianluca.gatti@unical.it)

Host University/Institute: University of Calabria

Research Keywords:	Energy Harvesting Nonlinear Dynamics Nonlinear Vibration
Reference ERCs:	PE8_7 Mechanical engineering PE8_1 Aerospace engineering PE7_2 Electrical engineering: power components and/or systems
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

Vibration energy harvesting from otherwise dissipated kinetic energy in the environment has attracted intense research effort in the past decades, as it can be a sustainable way to reduce the use (and subsequent disposal) of batteries or the need of cables. This is particularly relevant in remote or hostile environments. For harmonic excitation, the best energy harvester is a tuned linear spring-mass-damper oscillator. However, when excitation consists of a wide spectrum, the performance of a linear device drastically decreases and nonlinear stiffness has been proposed to enlarge its bandwidth. One first critical issue is the appearance of multi-stable amplitudes of oscillation, with different energy levels. For energy harvesting purposes, it is desirable for the device to oscillate at one of the highest amplitudes, and several active control strategies have been proposed to steer the oscillation as desired. They however detract energy from the harvested one. A second critical issue manifests when it is of interest to harvest energy at very low frequency (e.g. by wind, passing trains, walking persons, or sea waves) using a linear device. This requires a suspension spring with extremely low stiffness and very large static deflection. A relatively long elastic element, however, can introduce undesired dynamics. From the electrical point of view, signal rectification and AC-DC conversion with high-efficiency are also critical issues.

This research aims at studying the fundamental benefits of exploiting nonlinear dynamics and design efficient energy harvesting systems, addressing the limitations mentioned above. The state of the art in modeling energy harvesters will be analyzed. Innovative solutions will be investigated using a multidisciplinary mechatronic approach. Prototype devices will be constructed to perform experimental tests and validate the theoretical expectations.

Research team and environment

The research activity will be carried out at the Mechanical Engineering Lab – Mechatronic Division of the University of Calabria in collaboration with the Measurements of Optical and Electronic Systems Lab of the Polytechnic Milan, and with the Integrated Microsystem and Sensor Lab of the University of Pavia. The overall research group consists of 3 Full professors, 2 Associate professors, 2 Researcher, 3 Post-doc fellows, and several PHD students. The team has recognized expertise in nonlinear dynamics, vibrations, mechatronics, electronic measurements and power electronics, with both theoretical and experimental skills. It has fruitful collaborations with several Universities and Research Centers abroad, e.g. UNESP (Brasil), ISVR (UK), INP-Toulouse (France), IMEC (Belgium), as well as international industrial partners, e.g. STMicroelectronics, Infineon. It is thus expected that part of the research work will be spent abroad in at least one of these Institutions.

Suggested skills for this research topic

Good background in mechanical engineering, with electronics, measurements, data analysis and programming skills (MATLAB) are required. Candidates with good knowledge in mechanical vibrations and nonlinear dynamics are encouraged. Working enthusiasm, creativity and attitude to problem solving are welcome.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.20

Curriculum: 3. Technology and Territory

Nature Based Solutions for the Sustainable Smart Cities of the Future

Reference Person: Lombardi Patrizia (patrizia.lombardi@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Nature based Solutions (NBS) Sustainable Smart Cities Planning Digital Transformation
Reference ERCs:	SH7_6 Environmental and climate change, societal impact and policy SH7_7 Cities; urban, regional and rural studies SH7_5 Sustainability sciences, environment and resources
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The consequences of global climate change are already being felt on every continent in the world. Global warming is bound to have a multitude of negative consequences, including the exacerbation of the intensity and occurrence of natural disasters. Having dealt with the COVID-19 pandemic crisis and being aware of the need to cope with climate change adaptation and mitigation, cities are promoting new ideas, striving to implement inclusive co-design processes in Visionary Solutions (VS) planning and design, and rethinking urban spaces in a healthier and greener way.

In response to systemic shocks and the global dynamics of change and vulnerability of territories, this PhD research will explore the use of Nature-based Solutions (NBS) for spatial and urban planning from an ecosystem resilience perspective, considering multiple criteria. The European Commission has defined NBS as solutions inspired and supported by nature that provide multiple benefits toward resilient development. On the other hand, another concept that has emerged is the Sustainable Smart City, defined as a place where traditional networks and services are made more efficient by the use of innovative technologies, digitisation of systems. In this context, the VSs based on urban digital transformation and nature-based actions, are proposed by an ongoing H2020 project, named VARCITIES – Future cities (https://www.Varcities.Eu). It aims at implementing the definition of NBS, proposing

the resolution of well-known local urban issues by addressing them from a new perspective capable of combining technologies and experimenting innovative approaches.

This PhD research will be partially conducted in the context of VARCITIES, for which EURAC is one the involved partner and the data collected of its relative pilot cities will be the basis of the research analysis. In fact, these pilots could be investigated to explore NBS which are innovative either in their functional scope, socio-economic reach, integrative approaches or application in new settings.

The objectives of this research are: (i) Analyse the effect of VSs integrated and designed in the citizens wellbeing employing a participatory co-design process involving local stakeholders and assuming multiple criteria; (ii) Shift towards the combined use of NBS and innovative technological solutions to restructure the cities governance practices; (iii) Provide appropriate approaches based on citizen science, artificial intelligence tools to better communicate the science of NBS and promote citizen engagement in the co-creation and co-implementation of NBS.

Indeed, the implementation of VSs requires not only technical know-how, but also the mobilisation of competences and skills from all institutional sectors, in particular during the co-design phase. Into this, the proposed interdisciplinary methodology starts by conducting a comprehensive and systematic literature review. Afterwards, the technical and social methods and models will be integrated and created. Finally, the application and validation of the proposed model will be implemented on different pilot studies.

This PhD research intends further to contribute as a basis for future EU projects and to the New European Bauhaus initiative by supporting the digital transitions in communities' living environments through merging sustainability, innovation and inclusiveness.

Research team and environment

The PhD activities will be a joint research activities between Politecnico di Torino (https://www.Dist.Polito.It/) and EURAC research center (https://www.Eurac.Edu/en). The activity will mostly take place in the (S3+Lab) "Urban Sustainability & Security Laboratory for Social Challenges" laboratory which is part of the SDG11Lab of the Interuniversity Department of Regional and Urban Studies and Planning, Politecnico di Torino, which integrates all existing relevant platforms and operating solutions for providing an infrastructure with a horizontal component, able to guarantee efficient access to general and reference data sources, and to host a variable number of vertical domains that require specific data and dedicated analysis tools. Being also a part of an EURAC Research project, the PhD candidate will spend at least 6 months at this research institute. The PhDs daily activities will be supervised by the main tutor (prof. Patrizia Lombardi) with the contribution of the full environment of the laboratory and in particular of Dr. Sara Torabi Moghadam (Polito) and Dr. Adriano Bisello (EURAC).

Suggested skills for this research topic

PhD candidate to be involved in this project is expected to have interest in theoretical perspective on Nature Based Solution (NBS) and spatial analytical tools for Sustainable Smart urban planning, competencies in LCA methodologies and GIS mapping for environmental evaluation. Moreover, the candidate should be familiar with the social research methodologies to provide appropriate approaches to engage citizen in the co-creation design of NBS.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.21

Curriculum: 3. Technology and Territory

Paradigm capsized: planning with tangible, manageable and measurable NbS

Reference Person: Marignani Michela (MARIGNANI@UNICA.IT)

Host University/Institute: University of Cagliari

Research Keywords:	NbS multiple benefits Urban biodiversity Mediterranean coastal areas
Reference ERCs:	LS8_1 Ecosystem and community ecology, macroecology SH7_5 Sustainability sciences, environment and resources PE10_4 Terrestrial ecology, land cover change
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

In the last decades, human pressure along the coastal zones increased worldwide, with several impacts on natural ecosystems: a third of the Mediterranean population lives in coastal regions, which will be the most affected by climate change and extreme events, thus making urgent to find adaptation and mitigation solutions, aiming at enhancing their resilience.

In this context, coastal cities represent a priority challenge, with a key role in supporting sustainable development and, at the same time, reducing pressures on natural ecosystems.

Nature-based Solution (NbS) have been recognized as an effective way to address such challenges by achieving ecosystem restoration and conservation, and simultaneously ensuring the sustainability of social and economic dimensions. The implementation of NbS in cities can enable urban and peri-urban areas to deliver multiple benefits and vital ecosystem services (ES), empowering them to address biodiversity loss, restore degraded land, increase resilience, mitigate and adapt to climate change. Nevertheless, while NbS approach, potentially provides a conceptual and operational framework that links multiple benefits with the protection of the natural capital, a lack of comprehensive evidence remains on NbS reversibility, flexibility, cost effectiveness and long-term feasibility and/or sustainability compared to gray approaches, especially in Mediterranean areas.

Main objective of the research proposal is to generate scientifically robust NbS monitoring and evaluation data, aiming at facilitating a full NbS integration into planning and design of urban coastal Mediterranean areas. Those data will offer examples of the positive chances that the NbS integration into decision-making can provide in strategic urban planning processes, providing evidence to support NbS efficiency and cost- effectiveness in comparison with traditional grey approaches

After the theoretical conceptualization, the research will investigate a specific case study, located in Sardinia, focusing on:

-Study area analysis: consultation of relevant plans and programs, urban trends, analysis of environmental, social and economic components.

-Identification and evaluation of the existing key components of the green infrastructure network: definition of natural components (e.G. Ecological corridors, trees outside the forest, protected areas) and assessment in terms of ecological processes and functions.

-Identification and evaluation of NbS: proposal for the implementation of the ecological network through urban regeneration actions and NbS (e.G. Green areas, ponds, woods fragments) to enhance the resilience of the study area to climate change. All the proposed solutions will be evaluated, as well as their trade-offs and synergies, according to the criteria and sub-indicators proposed for the standard framework for NbS design and assessment defined by the IUCN (2020).

-Development of tools for assessing and monitoring the cost- effectiveness in comparison with traditional grey approaches (e.G. Indicators, collaborative GIS).

The proposed approach will allow to prioritize sustainable management options, reducing conflicts of use and minimizing impacts on ecological integrity. In addition to offering concrete solutions for the case study, the project will also bring advances in the current debate on the lack of harmonization and operationalization of the integration of NbS into decision-making and strategic urban planning.

Research team and environment

The scholarship will work within the framework of the Department of Life and Environmental Sciences – Botany division of University of Cagliari. The researcher will have the possibility to work in a multidisciplinary team, under the responsibility of Prof. Michela Marignani. Main scientific interests focus on landscape ecology, with studies on the effects of habitat fragmentation on multi-taxonomical diversity, the definition of ecological networks at different scales and spatial planning in urban and peri-urban environments. The team

performs multidisciplinary research activities, thanks to the collaboration with environmental engineers, urban planners, zoologist, geologist and ecologists.

Suggested skills for this research topic

We are looking for candidates with a good knowledge of ecology and ecological processes, as well as in natural resource planning and human dimension integration. The ideal candidate has a Master's degree related to sustainability science, natural and environmental sciences, ecology, biology or similar. Experience with statistics, spatial planning, environmental impact assessment and ecosystem services evaluation will be welcomed.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.22

Curriculum: 3. Technology and Territory

Multi-criteria decarbonisation analysis for remote and rural areas

Reference Person: Mattiazzo Giuliana (giuliana.mattiazzo@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Energy scenario making and analysis
	Local energy planning
	Energy systems operation and management
Reference ERCs:	PE8_7 Mechanical Engineering
	SH7_9 Energy, transportation and mobility
	SH7_6 Environmental and climate change, societal impact and policy
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The decarbonisation targets set by the international community can be achieved by adopting an effective medium to long term energy planning strategy that can support local authorities' decision-making processes.

The sustainable development of social contexts is a three-dimensional problem involving different environmental, social, and economic levels. Consequently, detailed energy planning must consider a high penetration of RES in the energy system and the economic feasibility and social impacts on the host community. The latter cannot be evaluated only in terms of employment effects but also social acceptability. The abovementioned becomes even more true if the contexts considered are rural and remote areas, which make extensive use of fossil fuels, and local communities are more cohesive.

The decarbonisation of local energy systems should be pursued by evaluating the high-RES penetration and the environmental cost of deployment, maintenance and decommissioning. Following the three-dimensional nature of sustainable development, a successful plan must consider the socio-economic and financial sustainability of proposed solutions and spillover effects on citizenship, offering strategies to increase social acceptability.

The PhD aims to develop a multi-criteria analysis methodology, adopting scoring systems (es. GHG, ESG) to evaluate the performances of provided solutions in the framework of sustainable decarbonisation pathways for remote and rural areas. Moreover, the research aims at building scenario analysis tools to support the sustainable development decision-making processes.

Research team and environment

The PhD activities will be mostly at Politecnico di Torino at the Marine Offshore Energy Lab (MORE) a highly multidisciplinary research center, part of the Department of Mechanical and Aerospace Engineer (DIMEAS). The group is currently composed of 2 full-time professors, four post-doctoral research fellows (2 under the H2020-MSCA-IF programme), 12 PhD students, 8 post-master research fellows, and various under-graduate interns and thesis students. The group's expertise is centered on all aspects of offshore renewable energy, especially focusing on the conception, design, testing, and deployment of novel wave energy converter technologies and floating offshore wind turbines. In particular, the major and tangible result of the group is the Inertial Sea Wave Energy Converter (ISWEC), which has been tested in wave tanks at different prototype scales, in dry-test hardware-in-the-loop (HIL) facilities, and deployed offshore in both half-and full scale, respectively in the Adriatic Sea and the Strait of Sicily (Mediterranean Sea). Other relevant lines of research and innovation comprise of a point absorber wave energy converter, a pendulum wave energy converter (PeWEC), innovative floating substructure for floating offshore wind turbines, and energy system modelling for small islands enabling the energy transition, also being the national representative within the Clean Energy for EU Islands Secretariat.

Suggested skills for this research topic

The candidate should preferably be enthusiastic about the subject proposed. He should have the ability to present a scientific work both in oral and written form and have proactivity and parallel thinking. To carry out the PhD research goals, the candidate should have a background in:

, Ä¢ Energy system modelling

, Ä¢ Knowledge of RES plants design

, Ä¢ Good programming skills (e.G. Python, Matlab) and good knowledge of GIS software.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.23

Curriculum: 3. Technology and Territory

Holistic stochastic approach for sustainable energy transition of alpine cities

Reference Person: Menapace Andrea (andrea.menapace@unibz.it)

Host University/Institute: Free University of Bozen-Bolzano

Research Keywords:	Renewable Energy Transition
	Climate Neutral Cities
	Stochastic Energy Scenarios Modelling
Reference ERCs:	SH7_7 Cities; urban, regional and rural studies
	PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution
	PE6_11 Machine learning, statistical data processing and applications using signal processing (e.g., Speech, image, video)
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The proposed PhD project regards the development of an innovative methodology for sustainable energy planning aiming at supporting the energy transition of alpine cities from current fossil fuel-based energy systems to future smart and renewable ones. The focus of this work will be therefore put on the optimal planning procedure that will be based on a holistic modelling of the energy systems and a stochastic approach for the analysis of the various scenarios. The design criteria based on this techno-economic methodology are identified in the sustainable use of renewable and local resources (e.g., biomass and hydropower plants), the implementation of smart grids and storage, and the decentralisation of energy generation and recovery.

The main activities to be carried out are listed hereafter.

- Collection and validation of the demand and production of the different energy vectors and technologies in annual aggregated and hourly time-series format. Gathering of information about the business-as-usual energy systems and the potential local resources.

- Modelling of the energies systems by means of proper advanced energy system analysis software to reproduce the current energy scenario. Using a holistic approach several sustainable alternative systems will be investigated including several cutting-edge

technologies, complex interaction among the energy vectors (e.g., heating, cooling, electricity and transport), renewable energy sources and smart grids (e.g., district heating and cooling, and hydropower systems).

- The input data of the energy model, comprising the energy demand and the renewable production, will be modelled through proper statistical methods that also evaluate the long-term climate change projection. Particular attention will be done on the modelling of the district scale that will be crucial for a reliable analysis of some innovative options, such as prosumers, district heating and energy communities.

- Merging the holistic energy modelling approach with the statistical inputs modelled the candidate will perform the final statistical analysis about the different long-term scenarios.

- The optimal planning alternatives will be finally figured out through a multiple criteria decision analysis.

- The analysis and comparison of the applications in different cities will be performed with the final aim to achieve useful information for sustainable energy planning into the alpine region.

Thus, a holistic-stochastic energy planning methodology will be obtained by coupling robust hourly energy simulations and stochastic modelling of the systems scenarios with a flexible multiple criteria decision analysis to identify the best scenarios. The methodology will be tested on a few alpine towns characterised by different features in order to define some long-term sustainable scenarios able to meet the climate change mitigation targets. The results of the test cases will be analysed and compared to seek the general trends useful for energy design guidelines of the alpine regions.

The main practical implication of this work should be to provide a reliable planning procedure suitable for small urban centres in the alpine region. This methodology should be able to support the decision-making process of local public administrations in the optimize long-term investments for reducing greenhouse emissions and increasing the share of renewables.

Research team and environment

The development of the proposed research project needs a wide range of knowledge comprising urban energy planning, sustainable energy resources evaluation, energy system modelling, statistical energy data analysis, optimization algorithms, smart energy district implementation, climate change projection, and econometrics. Therefore, the candidate will collaborate with a multidisciplinary group of professors and researchers including the Faculty of Science and Technology, Faculty of Economics and Management and Faculty of Computer Science of the Free University of Bozen-Bolzano. In addition, the candidate will have the opportunity to collaborate with the extensive network of partnerships, which comprises for instance the Department of Planning of the Aalborg University. The candidate will be involved in the activities of the presented above research group for the sustainable development of

smart and renewable-based urban energy systems aimed at talking about climate change. The alpine context will be deeply analysed in order to properly figure out the most suitable energy resources, technologies and solutions. The main findings will be shared with local public administrations to support the decision-making process of urban energy planning and policy definition.

Suggested skills for this research topic

The candidate should possibly be highly interested in the research topic, enthusiastic to work in a multi-disciplinary team but also inclined to solve problems independently, ambitious and not afraid to share any ideas. In addition, the candidate should have the problem-solving capability, be hungry for new knowledge and be willing to overcome her/his limits. The candidate should have the ability to organise and plan work, schedule tasks and meet deadlines.

At the same time, a master degree in a technical-scientific area is required, such as Energy, Civil or Environmental engineering. Good knowledge of energy systems modelling, energy demand analysis, energy production systems, renewable energy sources, cutting-edge energy technologies, smart energy grids and communities, energy storage, energy economics and energy policies are strongly recommended. The following technical skills are advisable: software tools for energy systems analysis (e.g., EnergyPLAN) and geographical information systems (e.g., QGIS), and programming language for calculation, statistical analysis and graphics (e.g., R, Python or Matlab).

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.24

Curriculum: 3. Technology and Territory

Flexible buildings as thermal storages for RES integration and smart cities/territories

Reference Person: Pagliano Lorenzo (lorenzo.pagliano@polimi.it)

Host University/Institute: Politecnico di Milano

Research Keywords:	Flexibility Energy storage Flexibility services
Reference ERCs:	PE8_3 Civil engineering, architecture, offshore construction, lightweight construction, geotechnics PE1_20 Control theory, optimisation and operational research
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

The expected increasing penetration of variable renewables in the energy mix and electrification of thermal uses in buildings and mobility, will create challenges for the electricity system and require large land takes for collection and storage of energy. Increased extraction of needed materials will also put pressure on territories and communities.

Reducing energy needs and making flexible the time of demand is essential to reduce size of collection, storage and transport infrastructure and its environmental impacts and overall costs.

Presently most buildings are extremely rigid in terms of time of energy demand. E.g. Heating systems are turned on early morning in winter in the nearly the entire building stock to recover from the drop in temperature overnight due to the high thermal losses via envelope and ventilation. In this situation, substitution of gas boilers with electric heat pumps would create an extremely challenging electric peak demand at the time of early morning recovery from night thermostat set-back. Buildings have the potential to act as thermal batteries but presently are in majority short-circuited to external cold sinks. By retrofitting buildings with thick external insulation layers, high performance fenestration, external solar protections and mechanical ventilation with heat recovery, their energy needs for heating and cooling may be reduced to very low levels. Much less explored, to the point of not being present in the Smart Readiness Indicator EU framework, is the effect of such retrofits on the flexibility of

demand. The thermal capacity of typical building typologies in Italy and Europe is high and, when protected from quick discharge, may enable buildings to remain in the thermal comfort range (as reported in EN 16798 and ASHRAE 55) up to several days without any active energy input.

This would allow:

, Ä¢ matching the building hourly demand profile with the supply of local energy (renewable or recovered energy) on a scale from few hours to a few days

, Ä¢ storing renewable or recovered waste energy when overabundant on the grid(s)

, Ä¢ managing conditions of energy supply shortage / high costs on the grids by modulating the demand profile over time (demand response, peak shaving, potential participation in the capacity market)

, Ä¢ protecting occupants during extreme weather events which may disrupt supply of electricity and fuel for a number of days.

This research will:

, Ä¢ develop Model Predictive Control (MPC) algorithms for flexibility services (e.g. The charging and discharging of energy in the thermal capacity of building structures, while maintaining comfort; the charging and discharging of added thermal capacity as water tanks,, Ä¶) that would enable buildings to actually act as elements of smart grids and energy communities and respond to dynamic conditions of weather and grid state.

, Ä¢ test those MPCs via calibrated simulation models (e.g. Energyplus + Python) and tune them to optimise a series of chosen flexibility indicators within given energy and comfort constraints

, Ä¢ test the optimised MPCs in real, occupied buildings, with a special interest on commercial buildings

, Ä¢ assess of the impacts of dynamic exploitation of flexibility at building, district and national energy system level (e.g. Participation of building aggregations to the capacity market, adding flexibility and hence increased options for RES integration to new energy communities, reduction of land-take in line with UN-SDGs goals and EU parliament - “no land degradation” by 2030 and “no net land take” by 2050 at the latest -)

, Ä¢ feedback to EU Smart Readiness Indicator methodology, presently under test and potentially open to evolution.

Research team and environment

The research team is the end-use Efficiency Research Group (www.EERG.Polimi.It), active at Polimi since 1996 under the direction of Prof. Pagliano, with collaboration with a number of European Universities, Fraunhofer Institute, Lawrence Berkeley National Laboratory, California University, ...

EERG has participated in, promoted and directed more than 50 research projects and studies funded by public (e.G. European Union, Regional Governments, National Ministries, ENEA,) and private bodies (e.G. Electric Companies) on various aspects of buildings analysis and simulation, buildings monitoring, comfort surveys and energy economics and planning, with a special focus on end use efficient technologies and programmes. We have participated and currently participate in activities of Energy in Buildings and Communities Programme

Of the International Energy Agency, such as: IEA ECBCS Annex 5 - ""Air Infiltration and Ventilation Centre; IEA EBC Annex 58 - ""Reliable Building Energy Performance Characterization Based on Full Scale Dynamic Measurements""; IEA SHC Task 40 / ECBCS Annex 52 - ""Towards Net Zero Energy Solar Buildings""

For this scholarship it is planned a period of internship at *Comune di Milano, Milano*

Suggested skills for this research topic

The ideal candidate should have good foundations in building physics and control methods, being acquainted with measurement procedures in buildings, being able of critical and evolutive use of building simulation. Good knowledge of English language, interest in scientific communication both at conferences and via peer reviewed journal papers. Ability or interest to learn and communicate in Italian language is also appreciated, for communication with Italian actors.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.26

Curriculum: 3. Technology and Territory

Implementation of local energy communities: hardware infrastructures and software logic

Reference Person: Poggio Alberto (alberto.poggio@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Energy Communities
	Hardware infrastructure
	Data analysis
Reference ERCs:	PE7_2 Electrical engineering: power components and/or systems
	SH7_5 Sustainability sciences, environment and resources
	PE7_8 Networks, e.G. Communication networks and nodes, Internet of Things, sensor networks, networks of robots
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The European Climate Act and the Fit for 55 EU directive have set increasingly challenging targets to reduce emissions and increase the development of renewable energy sources.

To achieve these goals, distributed generation from renewable electricity will have the greatest prospect of growth, both to cover civil and industrial electricity needs, and as part of the electrification process of the transport sector, also through the development of energy communities.

The 'Green Revolution and Ecological Transition' and 'Infrastructure for Sustainable Mobility' are in fact two of the six key themes of the PNRR, themes within which the following proposal fits to support the sustainable development and use of local resources. (Mission M2C2 - Renewable Energy, Hydrogen, Grid and Sustainable Mobility | Investment 1.2: Promoting Renewables for Energy Communities and Self-Consumption; Investment 2.1: Strengthening the Smart Grid. Mission M2C1.3 Develop integrated projects | Investment 3.2: Green communities).

The doctoral research will focus on the development of simulation and optimisation techniques to maximise the energy, environmental and economic performance of local energy communities and prosumers, and hardware devices to support smart grids.

Optimisation systems will be implemented based on deterministic techniques, such as Mixed-Integer Linear Programming systems, and stochastic methods such as artificial immune networks. In addition, the research will apply game-theoretic and agent-based model methods, where different actors interact to optimise the exploitation of renewable energy sources such as energy communities and energy storage systems.

Data analysis techniques such as clustering techniques and machine learning methods (linear regression, support vector regression and artificial neural networks) will be involved. The application of these techniques in the energy sector (energy demand forecasting, user needs analysis, etc.) has already provided good results in terms of accuracy and computational efficiency compared to more traditional simulation techniques and has now reached a degree of development that can be applied to real energy systems.

The hardware infrastructure and the software platforms for the implementation of the identified solutions will then be defined, also in the context of the current energy market and its evolution, and their application on pilot cases developed in collaboration with local energy operators.

Research team and environment

Politecnico di Torino carries out education, research, technological transfer, and services in all sectors of architecture and engineering. The Department of Energy is the point of reference in Politecnico di Torino for the areas of knowledge concerned with energy and sustainable development. The candidate will join the Sustainable Energy Analysis (SEA) and the Computer Aided Design of ElectroMagnetic Apparatuses (CADEMA) research groups that works on local energy planning and on optimization procedures to energy management and network systems.

SEA research group is coordinated by prof. Alberto Poggio. Main research topics addressed concern: energy transition at urban and regional scale, energy analysis of industrial processes and cogeneration plants, sustainable supply chains for wood biomass energy, renewable heat for district heating. SEA team integrates a knowledge of energy technologies with multi-scale analysis, from the individual user or plant up to an entire territory, and a multidisciplinary approach, including issues related to climate change, air quality, territorial management, local development.

CADEMA research group is coordinated by prof. Maurizio Repetto and groups professors and researchers mainly belonging to the scientific sector of "Principle of Electrical Engineering" with competences in simulation and optimization of complex system by means of evolutionary and neural computation. Analysis tools have been developed for hybrid energy systems and for multi-agent sharing structures as the one of energy community.

Suggested skills for this research topic

Good knowledge on: energy systems modelling, energy data analysis, energy generation and distribution, energy self-production at user scale (prosumer), renewable energy resources. Base knowledge on: data processing, data analysis and spatial representation software (e.G. Excel, Matlab, R studio, GIS).

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD course). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.25

Curriculum: 3. Technology and Territory

Simulation and optimisation of energy community energy flows by computational intelligence

Reference Person: Poggio Alberto (alberto.poggio@polito.it)

Host University/Institute: Politecnico Di Torino

Research Keywords:	Decarbonization Energy transition Renewable energy communities
Reference ERCs:	PE7_2 - Electrical engineering: power components and/or systems SH7_5 Sustainability sciences, environment and resources SH7_10 GIS, spatial analysis; big data in geographical studies
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The European Green Deal aims to reduce net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. Renewable energy policies must make an important contribution to achieving this challenging objective. In the ongoing revision of the Renewable Energy Directive (RED), it is proposed to increase the overall share of renewables to 40%.

Buildings and transport will drive the energy transition; in both these end-use sectors, progressive electrification is expected:

- in transport, with an increase in vehicle charging consumption and new opportunities for short-term grid balancing and storage services;
- in buildings, with a growing role of heat pumps and new issues of coupling of the heat and electricity demand profiles.

To face this strong increase in electricity demand, a high penetration of renewables is needed.

Currently the generation and use of renewable electricity is based on two main configurations: i) large plants that feed into the grid; ii) small plants for the self-consumption of single users. Both approaches have structural limitations. The concentration of generation in large plants can lead to significant environmental and land consumption impacts. In

addition, centralized generation processes can be inefficient with respect to the localization and the dynamics of energy demand. Distributed generation of individual users avoid the main part of impacts issues. Typically, the design criteria of small plants is optimized on the real energy needs of single users. But, from another point of view, the size of individual plants is often smaller than the onsite available installation capability. In this way, much of the renewable potential is untapped.

Sharing energy is the key practice to overcome these limitations in and to enable further developments of renewable generation. According to definitions of RED, local energy communities are the main instrument to allow energy sharing and value exchange between different users. The concept of energy community is evolving rapidly: from small associations for photovoltaic generation and self-consumption to complex energy systems containing different energy sources in a wide territorial extension.

The PhD research will focus on the development of simulation and optimization techniques to maximize energy, environmental and economic performance of energy communities. Multiplayer systems will be considered, in which different actors interact to optimize the exploitation of renewable sources such as energy communities and systems with energy storage of different forms (thermal, electrochemical, hydrogen, etc.). Data analysis techniques will be involved, such as clustering techniques and Machine Learning methods, such as linear regression, Support Vector Regression and artificial neural networks. The application of these techniques in the energy fields (energy demand prevision, user needs analysis etc.) has already provided good results in terms of accuracy and computational efficiency if compared to the techniques of more traditional simulations and has now reached a degree of development that can be applied in real energy systems. Therefore, this approach will be applied to the study of the design and operation of energy communities based on real case studies.

Research team and environment

Politecnico di Torino carries out education, research, technological transfer and services in all sectors of architecture and engineering. The Department of Energy is the point of reference in Politecnico di Torino for the areas of knowledge concerned with energy and sustainable development. The candidate will join the Sustainable Energy Analysis (SEA) and to Computer Aided Design of ElectroMagnetic Apparatuses (CADEMA) research groups that works on local energy planning and on optimization procedures to energy management and network systems.

SEA research group is coordinated by prof. Alberto Poggio. Main research topics addressed concern: energy transition at urban and regional scale, energy analysis of industrial processes and cogeneration plants, sustainable supply chains for wood biomass energy, renewable heat for district heating. SEA team integrates a knowledge of energy technologies with multi-scale analysis, from the individual user or plant up to an entire territory, and a multidisciplinary approach, including issues related to climate change, air quality, territorial management, local development.

CADEMA research group is coordinated by prof. Maurizio Repetto and groups professors and researchers mainly belonging to the scientific sector of "Principle of Electrical Engineering" with competences in simulation and optimization of complex system by means of evolutionary and neural computation. Analysis tools have been developed for hybrid energy systems and for multi-agent sharing structures as the one of energy community.

For this scholarship it is planned a period of internship at *URMET Telecomunicazioni, Torino*

Suggested skills for this research topic

Good knowledge on: energy systems modelling, energy data analysis, energy generation and distribution, cogeneration, district heating, energy self-production at user scale (prosumer), renewable energy resources, technologies and supply chains (e.G. Wood biomass, solar thermal and photovoltaic, hydrothermal and aerothermal by heat pumps). Base knowledge on: data processing, data analysis and spatial representation software (e.G. Excel, Matlab, R studio, GIS).

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.27

Curriculum: 3. Technology and Territory

Biocatalytic transformations in unconventional green solvents

Reference Person: Prandi Cristina (cristina.prandi@unito.it)

Host University/Institute: University of Turin

Research Keywords:	Biocatalysis Green processes Fine chemicals
Reference ERCs:	PE5_17 LS1_2
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 4: Quality Education, GOAL 5: Gender Equality, GOAL 6: Clean Water and Sanitation, GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

Biocatalysis has become a valuable method for manufacturing chiral synthons for agrochemicals and pharmaceuticals due to its high intrinsic regio-, chemo- and stereoselectivity. Furthermore, as biocatalysts operate under mild (physiological) conditions they are often compatible with each other rendering them suitable for multi-step cascade processes in one pot. Cascade reactions are very attractive as yield-reducing intermediate product isolation is not necessary. Additionally, improved step- and atom economy translate into significant economic and environmental benefits. Apart from a few exceptions, enzymes display the highest activity in buffered systems; however, most of the industrially relevant substrates are hydrophobic and hence hardly soluble in aqueous buffers. If emulsions or two-phase systems are not suitable for the respective biocatalyst, overall productivity of these biotransformations is limited. Inactivation can be circumvented when enzymes are operated as whole cells. Here, the implementation of living cells, resting cells or even lyophilised cells is an option. The cell envelope may protect the enzyme from the organic exterior by providing an environment closer to nature. Often the application of organic solvent also facilitates product isolation as tedious product extraction from an aqueous phase can be omitted. Hence, biocatalytic cascades using whole cells in organic media offer a highly potent alternative to standard chemical syntheses to establish cheap, selective and efficient production processes.

In this PhD project, biocatalysts as isolated enzymes or as whole cells will be used in unconventional green solvents, mainly Deep Eutectic Solvents to promote chemo-. Regio- and stereocontrolled transformations leading to target compounds as fine chemicals of pharmaceutical or agrochemical interests.

Research team and environment

The research team is composed by myself (full professor in organic chemistry) and:

2 associate professors

1 post doc

3 PhD students

2 graduate students

5 thesis students

Suggested skills for this research topic

The candidate should be familiar with:

Organic synthesis and basic principles of catalysis

Green chemistry

Enzymes

Protein structures and biocatalytic mode of actions

Whole cells catalysis

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU3.28

Curriculum: 3. Technology and Territory

Sustainable Energy Communities

Reference Person: Raugi Marco (marco.raugi@unipi.it)

Host University/Institute: University of Pisa

Research Keywords:	Sustainable energy Energy Communities Data Analytics
Reference ERCs:	PE8_6 PE7_3 PE6_11
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

The research topic is the same included in the first PhD-SDC cycle (XXXVII).

The object of the research is the identification of solutions of complete self-sufficiency for energy communities

Through innovative methods for the integration of electrical and thermal systems, powered only by renewable

Sources produced locally (solar, wind, geothermal, biomass, etc.). ICT technologies and artificial intelligence will

Be adopted. Future scenarios are studied in which it is not sustainable to use the electricity and gas grid and the

Energy needs of civil, industrial and agricultural buildings must be satisfied with only renewable sources to be

Produced on site. In this scenario, it is necessary to study a completely innovative case in which it will be

Necessary to adapt the energy demands of users (negotiating consumption for civil uses with those for industrial

Use) with the energy available in terms of both overall consumption and hourly distribution. This perspective

Induces a radical change in current habits and lifestyles in terms of citizens' consumption and productive

Activities. Specific research topics are: integration of storage systems, renewable sources, utilities with ICT

Technologies and electronic platforms to maximize sustainability and energy efficiency. Development of artificial

Intelligence systems based on the monitoring of energy consumption and climatic conditions of buildings and

Plants to provide an information system to aid decisions. Socio-economic investigation, also through

Gamification techniques, to obtain profiles of energy needs in the prefigured context and understand their social

Acceptability.

Research team and environment

The research team is composed by professors of the Department of Energy Systems Constrction and Technology Engineering, in particular Prof. Daniele Testi, Prof. Marco Raugi and Prof. Mauro Tucci. The candidate will also operates in the very stimulating framework of the Interdipartmental Research Centre on Energy for Sustainable Development https://ciress.It/ where many experts on Electric Engineering, Electronic Engineering, Computer Science, Thermal Engineering etc etc will dialogue, help and guide the student activities.

Suggested skills for this research topic

The candidate should have a good mathematical background and computer programming skills.

Energy systems and energy systems integration knowledge and understanding will be considered as preference

Titles. If necessary the candidate will be formed on these topics during the first year.

Computer programming skills are necessary. Big data analytics and artificial intelligence methods (neural

Network, machine learning etc) will be considered as preference titles. If necessary the candidate will be formed

On these topics during the first year.

The candidate should be open minded and able to dialogue with colleagues with socio economic skills in order

To undestand the socio-economic interactions into an Energy Community

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.29

Curriculum: 3. Technology and Territory

Sustainable and Circular Manufacturing in the Digital Era

Reference Person: Rosa Paolo (paolo1.rosa@polimi.it)

Host University/Institute: Politecnico di Milano

Research Keywords: Circular Economy
Industry 4.0
Twin Transition

Reference ERCs: PE8_9

Reference SDGs: GOAL 12: Responsible Consumption and Production

Description of the research topic

Given the direct exploitation of materials and natural resources, the manufacturing sector is on the forefront of sustainability and circular economy. This way, the negative impact of this sector in terms of sustainable development and climate changes must be adequately monitored and reduced. During the last decade, both circular economy and Industry 4.0 approaches have been adopted by manufacturing companies in order to cope with environmental issues and technological advances. However, current researches are showing that digital technologies could support and enable even more sustainable practices if adequately integrated and managed. The intent of this research is to establish new ways to do it in practice and support companies during the transition from linear to circular behaviours.

Research team and environment

The research team will be constituted by Paolo Rosa (PhD in Economics and Management of Technology got @ University of Pavia in 2018) as main reference person, and Luca Fumagalli. Professors Marco Taisch and Sergio Terzi of the Manufacturing Group of the School of Management POLIMI will also be involved. The research activity will consider also the collaboration with other POLIMI's PhD students and post-doc operating in the Manufacturing Group, like Roberto Rocca, Federica Acerbi and Marco Spaltini. This will create a stimulating environment for the new PhD candidate. One main idea of the research team is to create cooperation with the MADE Competence Centre Scarl (where University of Pavia and Politecnico di Milano are academic partners). Given the current role of Paolo Rosa at MADE (as sustainability focal point), he will act as facilitator between the Manufacturing Group and MADE, by supporting the PhD candidate's activities. Some of these activities will be also implemented within the Manufacturing Groups' Industry 4.0 Lab @ Department of Management, Economics and Industrial Engineering of POLIMI.

For this scholarship it is planned a period of internship at *MADE scarl, Milano*

Suggested skills for this research topic

Good knowledge of circular economy practices and industry 4.0 technologies

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.30

Curriculum: 3. Technology and Territory

Chemometric optimization of synthesis of materials for adsorption of pollutants

Reference Person: Ruggieri Fabrizio (fabrizio.ruggieri@univaq.it)

Host University/Institute: Università degli Studi dell'Aquila

Research Keywords:	Adsorption
	Pollution
	Optimization
Reference ERCs:	PE4_5
	PE4_18
	PE4_9
Reference SDGs:	GOAL 6: Clean Water and Sanitation, GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production

Description of the research topic

The aim of this research program is to explore innovative approaches to the preparation of nanostructured materials, and to use these materials to remove pollutants and heavy metals present in soils or waters. The experimental conditions used to prepare the materials will be optimized by advanced chemometric tools. Chromatographic and spectroscopic analytical techniques will be used to evaluate the pollutant removal efficiency. In particular, during the project, analytical methods for the determination of pollutants will also be implemented. Chromatographic methods such as ion chromatography and high-performance liquid chromatography will be used during the project. In addition, emission spectroscopy will be used for the determination of heavy metals.

Research team and environment

The main objectives of our research activities are mainly the study of environmental issues. In particular, different materials are currently being studied for the decontamination of pollutants of xenobiotic origin present in environmental matrices. The team consists mainly of young PhD students and students of the degree course in chemistry. The main analytical instruments are present in the laboratory, such as GC-MS, HPLC, ICP-MS and IC.

Suggested skills for this research topic

Knowledge of the main chemometric techniques, autonomy in laboratory practices with excellent knowledge of chromatographic techniques and atomic emission spectroscopy

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.31

Curriculum: 3. Technology and Territory

Electro-nanocatalytic approaches for high added value products

Reference Person: Sarno Maria (msarno@unisa.it)

Host University/Institute: University of Salerno, via Giovanni Paolo II, 132 - 84084 Fisciano (SA), Italy

Research Keywords:	Electro nano-catalysis Biomass and CO2 valorization Chemicals and syngas production
Reference ERCs:	LS9_11 Biomass production and utilization, biofuels PE8_11 Environmental engineering, e.G. Sustainable design, waste and water treatment, recycling, regeneration or recovery of compounds, carbon capture & storage PE11_9 Nanomaterials engineering, e.G. Nanoparticles, nanoporous materials, 1D & 2D nanomaterials
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 13: Climate Action

Description of the research topic

Electrochemical processes are now a real opportunity for obtaining various chemical products at low temperatures and ""easily"", even starting from waste and biomass, water and CO2. In this context, it is extremely important to design nano-catalysts, through morphologies, couplings and “ad hoc” compositions to improve the processes performance. Electricity supplied from renewable energy sources allows for sustainable productions, and can be a real smart approach.

A large amount of agricultural wastes, other recycled feedstock’s and more in general biomasses contain a high amount of lipids. Because of their non-toxic and environmentally friendly nature, biodiesel obtained from renewable resources has become very attractive. Biodiesel production can be achieved through esterification and/or trans-esterification of fatty acids, in the presence of alcohols and inorganic or enzymatic catalysts. The advantages of enzymatic catalysis, which doesn’t require pre-treatment and operates in the presence of water moisture, are the high selectivity, flexibility to handle feedstock and feedstock amount variations, mild operating conditions, free fatty acid (FFA) processing, “eco-friendly” nature, simultaneous esterification and transesterification. Enzymes immobilization allows overcoming the main drawbacks, which are free enzymes, poor stability, and costs. Enzymatic immobilization on nanoparticles based on a suitable design and optimization can

significantly enhance catalytic performance. For enzyme immobilization, non-toxic magnetite is one of the most explored supports. On the other hand, new, more preforming solutions, using innovative and cheap nano-magnetic supports, are highly desirable. In particular, improvement of the enzyme loading, low tendency to aggregate during recycling, are very desirable properties.

Carbon dioxide, which is the main greenhouse gas, represents today one of the major reasons of global temperature increase. One of the possible ways to reduce CO2 emission is to capture and eventually valorise it. In this scenario, the main challenge is to develop new solutions with low environmental impacts. On the other hand, CO2, through a chemical way and use of non-fossil energy, can be transformed into chemicals, pharmaceuticals, or biofuels, e.G., syngas for mediated productions. Morphology control, catalyst composition, support effect, and adjustment of precisely exposed crystallographic facets were identified as the key parameters to improve electro-activity and selectivity of catalysts. Moreover, the observation that hydrogen evolution reaction (HER) is an inevitable rival reaction of the reduction of CO2 in aqueous media, suggests attempting for a competitive approach, in search for the simultaneous CO2 conversion and hydrogen production. The achievement of this goal requires the design of a catalyst capable, by virtue of multi-functionalities and multi-constituents, to produce controlled compositions: from CO to syngas and H2 with specific ratios.

In this scenario of electrochemical nano-assisted catalysis, the exploration of carbon nanomaterials as catalysts support, due to their conductivity, large specific surface area, high porosity, and relative chemical inertness results also of particular interest

Research team and environment

The PhD student will work inside the Interdepartmental Research Center NANO_MATES (Research Centre for NANOMAterials and nanoTEchnology at Salerno University) c/o Department of Physics of the Salerno University. NANO_MATES was born with the idea of generating a research network within the Salerno Campus to enhance the skills acquired in the field of nanosciences and nanotechnologies with a particular focus on sustainability through a strong synergy between researchers from several departments. In particular, the research team mainly composed of Chemical Engineers, is constituted of 2 Full Professors, 3 Associate Professors, 2 PhD student, 3 senior researchers and several PhD/Post Docs responsible of different National and International collaborative projects. The laboratories are equipped with different facilities. For the characterizations, the following are available: Electron Microscopy (SEM, FESEM, TEM) with X-ray (EDX) and electron diffraction analysis (SAED), Magnetic Resonance Imaging (MRI), NMR and Raman spectroscopy, XRD, FT-IR and UV-Visible spectroscopy, thermal analysis (TG-IR), Ion Chromatography, N2 adsorption / desorption, particle size distribution and numerous plants for testing and process analysis.

Suggested skills for this research topic

Chemical Engineering

Environment Engineering

Nanotechnology

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.32

Curriculum: 3. Technology and Territory

Sustainable integrated strategies for preservation and maintenance of urban art

Reference Person: Scalarone Dominique Maria (dominique.scalarone@unito.it)

Host University/Institute: Università degli Studi di Torino

Research Keywords:	Innovative surface treatments Risk assessment of urban artworks Decision-making
Reference ERCs:	PE4_17 PE5_15 SH7_7
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production

Description of the research topic

The 2030 Agenda emphasizes the need to improve the well-being of urban centres. Today half of the world population resides in large urban agglomerations that cover only 3% of the surface of the globe. Between 60-70% of global energy is consumed in 3% of its territory. Art in all its forms and its conservation are a precious tool for increasing the well-being of the community, not only because it can have important economic implications, but also because art is able to strengthen the sense of belonging to a certain community. This is even more true for contemporary public art works, which often respond to a direct need of the community, like for instance many street art works, or are commissioned by institutions or individuals with celebratory intent or in the context of urban regeneration projects.

Unfortunately, outdoor urban works of art are continuously subject to the action of multiple agents of degradation, both anthropogenic (e.G. Atmospheric pollution, vandalism) and natural (e.G. Atmospheric agents), which cause their rapid degradation. Climate change abruptly modifies environmental conditions, making the picture of the mechanisms of degradation and their effects on urban works of art even more complex and dynamic than in the past.

This project aims to define methodologies, tools and best practices for the preservation and sustainable maintenance of urban works of art. The choice of materials, technologies and processes is fundamental to ensure the environmental and economic sustainability of any

preservation action. The PhD candidate will develop and test new solutions and protocols to identify environmental risks, to detect degradation processes, to effectively clean and protect the surfaces of outdoor urban works of art.

The working methodology will be based on:

- the use of innovative technologies (for the analysis of the condition state of the artworks) and materials (for the cleaning and protection of damaged surfaces)

- the attention to economic, environmental and social sustainability criteria

- the analysis of the socio-cultural and historical-artistic context of the artworks

- the analysis of the needs expressed by the community, by funding bodies of public art works and by institutions or authorities responsible for their maintenance.

Research team and environment

Most of the research activities will take place at the Department of Chemistry of the University of Torino where a research line on Cultural Heritage is active, involving experts in diagnostics, development of materials and methods for heritage conservation. In addition to the laboratories, equipment and services offered by the Department of Chemistry and by the other Departments and research groups of the University of Torino engaged in researches on Cultural Heritage, the project will benefit from the solid collaboration with a network of national and international partners who in recent years have shared and share research experiences centred on the theme of conservation of public art, urban decor and urban creativity, such as the European project CAPuS (Conservation of Art in Public Spaces, Erasmus + Knowledge Alliances Program) and the project SuPerStAr (Sustainable Preservation Strategies for Street Art, PRIN2020). The network includes universities (University of Pisa, University of Bologna, Politecnico di Milano, University of Split, University of Vigo), research centres (CNR), academies and conservation institutes (Conservation and Restoration Centre "La Venaria Reale", Academy of Fine Art in Warsaw, Cologne Institute of Conservation Sciences), museums, companies, local authorities and associations of artists and restorers. Through this network the access to the equipment and services of the E-RIHS.It infrastructure (European Research Infrastructure for Heritage Science www.E-rihs.Eu) is also provided, in particular as regards the application of the MOLAB-Mobile Laboratory Facility to contemporary urban art.

Suggested skills for this research topic

The ideal candidate is expected to have a technical-scientific background, preferably in the field of analytical chemistry and characterisation methods. Skills in polymer science and heritage conservation science and technologies will be positively assessed. The candidate must have an aptitude for interdisciplinarity, good critical and communication skills and a willingness to work in a heterogeneous team in terms of skills and background. The

successful candidate will need to be curious, highly motivated and independent in managing daily research activities.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU3.33

Curriculum: 3. Technology and Territory

Urban resilience and participation for the territory safety from risks

Reference Person: Spadaro Ilenia (ilenia.spadaro@unige.it)

Host University/Institute: UNIGE - University of Genoa

Research Keywords: Resilient spatial planning

Territory safety

Stakeholder participation

Reference ERCs: SH7_8 Land use and planning

PE8_11 Environmental engineering, e.G. Sustainable design, waste and water treatment, recycling, regeneration or recovery of compounds, carbon capture & storage

SH7_10 GIS, spatial analysis; big data in geographical studies

Reference SDGs: GOAL 11: Sustainable Cities and Communities

Description of the research topic

The main goal of the research is the definition and implementation of a resilient, participatory and therefore sustainable approach to the issue of the territorial safety from external risks. The natural and man-made disasters that have occurred in recent years show how the resilience of a city does not depend only on the actions carried out by public authorities but requires the joint work of all the actors who live or work in a city. Another aspect emerged is that the current instruments are not always able to plan and successfully manage the different phases that characterize the risks. The aim of the research is therefore to deepen the concept of exposure within the definition of risk.

Resilience represents the ability of an urban system to adapt to an external event and quickly return to normal. This research considers the topic of risk in relation to the concept of resilience in urban planning, participatory methodologies, technologies and policies. Urban resilience has become an important goal for cities (Agenda 2030 and/or National Recovery and Resilience Plan, PNRR in Italy, for example), particularly in addressing climate change.

Implementing resilience perspectives demands the definition of a multiscale and intersectoral approach. And this approach must support the transition and adaptation of institutions and communities through specific territorial governance strategies and urban planning tolls, to accomplish a sustainable and safe urban space.

Specific attention in the research is given to the involvement and participation of stakeholders. This proposal contributes to the implementation of the "Quadruple helix principle", according to which the involvement of these four actors - public bodies, research, businesses, citizens - is necessary to achieve a common objective, such as increasing urban resilience. For the definition of the methodology, according to the ""learning by doing"" approach, it will be useful to explore one or more case studies (mainly taken from experiences of local, national and European planning) to understand how the individual actors (mentioned above) have responded and collaborated, adapting in a resilient way, to natural and anthropic events they were subjected to. It's essential to consider places and times that characterize each exposure in order to create dynamic scenarios. The scenarios, created thanks to the GIS Geographic Information System, are defined to plan mitigation actions in times of peace and emergency. This last point refers to temporal urban planning (time-based urban planning approach) which can be strategic for building resilience in cities. In particular, the proposed methodology will have to reduce, mitigate the risk and increase resilience by identifying specific scenarios and actions that every citizen actor - public bodies, research, businesses, citizens - will be able to implement to attain the goal of sustainability (environmental, economic and social) and safety.

Research team and environment

The research activity will take place at the Department of Civil, Chemical and Environmental Engineering (DICCA) of the University of Genoa. The candidate will be part of the Urban and territorial planning working team. The PhD student will have access to the main researches developed on the topics: Strategic planning, Territory safety from natural events, Urban resilience (from natural and man-made disasters); Environmental, social and economic sustainability with attention to the participatory approach; Urban and territorial regeneration, with enhancement of internal areas; Sustainable mobility; Sustainable waste management; Sustainable and slow tourism; Sustainable energy; Promotion of the territory and creation / accompaniment of start-ups; Port planning and waterfront redevelopment. These researches are and have been carried out through European and national programs and research contracts with Public Administrations. In particular, the teachers of the team are part of the ""Sustainable UniGe"" working group.

Suggested skills for this research topic

The suggested profile is a graduate student in Civil or Environmental Engineering or Educational Sciences and Psychology. The PhD student should have: interest in participatory research, community involvement; skills in resilience, risks and participatory methodologies learned in courses, internships or degree theses; previous experience in European projects, preferably on the topics covered by the research; ability and willingness to work in a collaborative, multidisciplinary environment, with an interdisciplinary approach and interest. Other technical skills required: GIS or AutoCAD.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.34

Curriculum: 3. Technology and Territory

E-mobility and Smart-Grids

Reference Person: Testa Antonio (atesta@unime.it)

Host University/Institute: University of Messina

Research Keywords:	Decarbonisation of electric systems Smart-Grids E-Mobility
Reference ERCs:	PE7_2 Electrical and electronic engineering: semiconductors, components, systems PE7_12 Production, distribution and applications of the electric energy SH2_8 Energy, transportation and mobility
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

The decarbonisation of electric systems requires a rapid increase in the production of non-fossil electricity, as well as a significant improvement in the efficiency of the transport and use of electricity. This could be achieved through Smart-Grids, which are complex electric networks that exploit power and data infrastructures to ensure high levels of efficiency, sustainability, safety, resilience, continuity and quality of electricity supply. E-mobility deals with the development of land, sea and air vehicles which are powered by electric motors and which get their energy mainly from the electrical grid. Smart-Grids and E-Mobility are key pillars of the transition to a carbon neutral society, closely related to each other. In fact, E-Mobility is about to become a new important form of end-use of electricity and Smart-Grids will become the main energy source for transport, moreover, a spread of E-Mobility is fundamental to make profitable large investments on Smart-Grids infrastructures.

The scholarship will start with a deep insight on some possible interactions between E-Mobility and Smart-Grids. Among them:

, Ä¢ The low range and long charging times of electric vehicles could be addressed in the near future with E-Roads integrated into Smart-Grids, where electricity is supplied directly to moving vehicles through wireless coupling systems. However, more efficient and reliable wireless charging systems are required as well as suitable energy management strategies.

, Ä¢ Parked electric vehicles can be turned into active elements of Smart-Grids, providing highly valued demand response services (V2G). This requires efficient bidirectional power converters, communication protocols and suitable business models.

, Ä¢ Charging stations are rapidly spreading while their power is increasing in a rush to reduce charging times. However, some practical problems arise, related to the battery safety and lifetime, grid stability and power quality.

, Ä¢ Millions of tons of lithium-ion batteries decommissioned from electric vehicles will have to be disposed of in the coming years. Since recycling is not cost-competitive, a possible alternative is a ""second life"" batteries reuse as storage systems in Smart-Grids. This requires the development of methodologies for estimating benefits in terms of costs and environmental impact.

, Ä¢ Naval and air electric vehicles will spread rapidly in the coming decades. This will set new challenges in the design of on board power systems and energy storage systems as well as in designing Smart-Grids for ports and airports.

, Ä¢ Power electronics is an enabling technology for both E-Mobility and Smart-Grids. It provides the glue that holds together in a controllable way all the components of a Smart-Grid and is essential for the development of electric vehicles and charging infrastructures. Innovative SiC and GaN power devices will allow in the next years to overcome the limits of conventional silicon devices in terms of efficiency, operating temperature and power density. However, new circuit topologies, cooling systems, magnetic devices and control techniques suitable for the new devices are required.

One of these topics will be selected and innovative solutions will be addressed, either from a theoretical point of view, either from an experimental one.

Research team and environment

The E-mobility and Power Electronics research team at the Department of Engineering of the University of Messina is composed of a full professor, an associate professor, a lecturer and three Phd students. Experimental research activities are accomplished at the Laboratory of Electrical Drives and Power Electronics which has been developed over the years to carry out research in the fields of industrial automation, power converters, electric mobility, electric grids and exploitation of renewable energy resources. Among the available instrumentation are some systems for the development of digital twins, a grid simulator, a simulator of photovoltaic generators as well as measurement and monitoring systems for vehicular and

stationary battery packs. The team is partner of ST-Microelectronics, CNR and some Italian Universities and firms in research activities in the fields of E-Mobility and Smart-Grids.

Suggested skills for this research topic

The candidate should have a master's degree in electrical or electronic engineering and be familiar with simulation environments such as Simulink, Plecs, Psim, and Spice. Furthermore, a consolidated experience in laboratory activities is highly recommended, and in particular in the design, realization and experimental evaluation of electrical, electromechanical and electronic systems.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU3.35

Curriculum: 3. Technology and Territory

Connecting online musicians and audiences to reduce travels and pollution

Reference Person: Turchet Luca (luca.turchet@unitn.it)

Host University/Institute: University of Trento

Research Keywords:	Networked music performance systems Sustainable smart city Musical interactions
Reference ERCs:	PE6_9 SH5_5 PE7_8
Reference SDGs:	GOAL 4: Quality Education, GOAL 9: Industry, Innovation and Infrastructure, GOAL 11: Sustainable Cities and Communities

Description of the research topic

This PhD project will focus on the development of radically new technologies based on 5G and Multisensory Extended Reality which are capable of truly interconnecting musicians as well as musicians and audiences. Such technologies will allow musicians to perform, rehearse, teach and learn online, and audiences to experience concerts remotely. A system with such capability has several benefits for society and the environment which are relevant for sustainable development. Firstly, it allows to drastically reduce the time and costs for travels, while zeroing any pollution due to travels. This impacts several users and a set of activities, the musical ones, which are widespread across society. Moreover, the proposed system is useful for all situations in which travels are difficult. This includes non-optimal atmospheric conditions, physical disabilities of the users, or the position of the users in geographically isolated areas.

The need to conduct musical activities remotely (e.G., live performances, teaching and learning music, rehearsing, recreational music making) has been promoted markedly by the social distance measures posed by the recent worldwide COVID-19 pandemic. However, today it is still impossible to connect musicians as well as audiences over the Internet as in real-life. End-users need real-time solutions that truly give them the feeling of being together in the same environment, sharing the same experience. This is crucial for a successful joint coordination of sounds and movement, and eventually for realising strong feelings of shared musical experience and sense-making.

The combined use of 5G and Multisensory Extended Reality technologies have the unexplored potential to cater to musicians and audiences needs by providing low- latency interactions in shared virtual or augmented environments.

This PhD project will create multisensory technologies exploiting audio, visual, and haptic stimuli to generate compelling illusions of being present in shared virtual or augmented environments. It will also design, develop and evaluate the resulting musical interactions possible in such environment. For this purpose, we will adopt user-centered design methodologies, in particular participatory design. The project will investigate a wide variety of musical activities. It will also involve a wide user basis which includes amateur and professional musicians and concert-goers, and will consider several diversity factors such as gender, age, and disabilities.

Research team and environment

The project will be hosted at CIMIL, the Creative, Intelligent and Multisensory Interactions Laboratory. This is a research team of University of Trento lead by the applicant, which is currently composed by 4 PhD students and 1 Postdoc. The PhD candidate will have access to the Multisensory Interactions Laboratories, a research facility composed by two rooms fully equipped with material for audio-based and virtual reality based interactions.

The PhD candidate can also count on the expertise of other professors within the Department who have complementary expertise to those of CIMIL researchers, such as Prof. Fabrizio Granelli and Paolo Casari, experts in networks.

Suggested skills for this research topic

The successful candidate will have a background as a computer scientist as well as will possess musical knowledge. In particular it is required to have competences in human-computer interaction as well as expertise with software frameworks for Virtual Reality and audio processing

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.