

DOCTORATE RESEARCH PROGRAMMES ON SUSTAINABILITY / INNOVATION-RELATED TOPICS

Attachment 2

PHD PROGRAMME IN ELECTRICAL AND INFORMATION ENGINEERING XXXVII CYCLE

Department: Department of Electrical Engineering and Information

Coordinator: Prof. Mario Carpentieri (mario.carpentieri@poliba.it)

Places available:

- “Innovation” macro-area: 3 places
- “Sustainability” macro-area: 3 places

Candidates are advised that there are separate application calls for each macro-area. Candidates who intend to apply for both programmes must submit two different applications for each macro-area.

The current document includes attachments regarding specific details for research topic fields for each macro-area.

Admission Requirements

Applicants to the PhD programme in Electrical and Information Engineering are required to hold a second level (specialized) degree as follows:

- Degree diploma awarded by the Italian university system prior to Ministerial Decree 509/99;
- Specialist Degree (as per Ministerial Decree 509/99);
- Master’s Degree (as per Ministerial Decree 270/04);
- Degree qualifications awarded by foreign universities officially recognised as equivalent to the above.

The Selection Committee will decide upon the eligibility of qualifications as part of the qualification assessment procedure.

Application Instructions:

Please note that the information provided in this paragraph **complements and does not substitute** that contained in arts. 2 and 3 of the Call for Applications document.

REQUIRED DOCUMENTATION

Candidates **must** upload the following documentation to their online application. **Failure to do so will result in their exclusion from the selection procedure:**

1. A CV following the **example format** provided by Politecnico di Bari on the Politecnico website www.poliba.it in the *Ricerca/Dottorati di Ricerca* section. This file should be named “01.CV”;
2. **A signed, valid identification document.** This file should be named “02.Documento riconoscimento”. ***Only the following documents will be considered;***
 - Only ID card issued by an EU member state;
 - Only driving licence issued by an EU member state;
 - In all other cases, a fully valid passport (also non-EU citizens, including the UK);
3. **Degree qualification certification for first (Bachelor) degrees and second (specialization/Master’s) degrees (or 5-year Single Cycle degrees).** A list of all exams taken with their relative marks in both degree courses (or the Single Cycle course) should also be included,

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following the example prepared by Politecnico di Bari which is available from the Politecnico website in the *Ricerca/Dottorati di Ricerca* section. This file should be named "03.Titoli di laurea".

Candidates with a **degree qualification awarded by a non-Italian university** must attach the following documents to their application, prepared by the academic institute which issued them. This supersedes any form of self-declaration:

- Degree certificate or diploma showing relative final mark;
- Official transcript of exams taken during all university study programmes, showing relative results;
- Any other type of document which demonstrates the equivalence of qualifications with those required in this application call (Supplementary Diploma, *Dichiarazione di Valore* (statement of value) issued locally).

These documents must be in Italian, French or English or translated into Italian or English and verified by an official Italian diplomatic or consular representative under the responsibility of the candidate. These should follow the guidelines set out in the document "*PROCEDURES FOR ENTRY, RESIDENCY AND ENROLMENT OF INTERNATIONAL STUDENTS AND THE RESPECTIVE RECOGNITION OF QUALIFICATIONS, FOR HIGHER EDUCATION COURSES IN ITALY FOR THE ACADEMIC YEAR 2021/22*" available at the link www.studiare-in-italia.it/studentistranieri;

4. **An abstract / summary of the thesis topic for specialist/Master's degree (or five-year Single Cycle degree)**, stating the title and name of thesis supervisor(s) (max 3,000 characters); this file should be named "04.AbstractTesi".
5. **The candidate's thesis for specialist/Master's degree (or five-year Single Cycle degree)**; for graduating students whose thesis is not yet complete (see art.2), a draft version of the thesis which has been completed up to the time of application; (N.B. *draft version* implies a version of the thesis text written by the graduating candidate up to the date of application, which, in terms of chapters and pages, allows the Selection Committee to evaluate its relative content and subject area. The abstract is uploaded as a separate file and is not considered as a *draft version of the thesis* under any circumstances. This file should be named "05.Tesi";
6. **Research project proposal**, which must be completed in the format provided by the Politecnico di Bari; this is available at www.poliba.it/it/dottorati-di-ricerca. The proposal must include:
 - research project criteria in line with art.3 of Ministerial Decree 16061/2021 and art.5 of the call for applications document;
 - research topics in accordance with the PhD programme selected and relevant macro-area topic (Sustainability/Innovation, refer to attached macro-area details).Proposals are assessed purely as part of the selection procedure and are not necessarily those which candidates will develop during the programme. This file should be named "06.Proposta di Ricerca".

OPTIONAL DOCUMENTATION

7. **A self-certification declaration for any other qualification deemed suitable for evaluation** which must be signed and dated and follow the layout of the example provided by Politecnico di Bari on the Politecnico website www.poliba.it in the *Ricerca/Dottorati di Ricerca* section. In accordance with art. 46 (Statements in lieu of Certification) and art. 47 (Self-Drafted Affidavits) of Presidential Decree 445/2000 (pursuant to art. 15 of Stability Law 183/2011, candidates may not submit certificates and affidavits issued by public administrations or providers of public services for qualifications that are to be assessed. These certificates should be replaced by statements as per arts. 46 and 47 of Presidential Decree n. 445/2000). This file should be named "07. Dichiarazione altri titoli";
8. (additional, optional) **Two letters of presentation from teaching staff** who have supervised the candidate throughout their university studies. These files should be named "08.Lettere presentazione 1", "08.Lettere presentazione 2";

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9. **Language certification** demonstrating a knowledge of English which corresponds to at least B2 level. Only non-Italian citizens can attach certification which demonstrates knowledge of the Italian language. This file should be named "09.Certificazione linguistica 1" (2, 3 etc);
10. **Any publications** related to activity carried out and shown on the candidate's CV. This file should be named "10.Pubblicazione 1" (2, 3 etc).

All of the aforementioned documents must be in either Italian or English or translated into Italian or English, under the responsibility of the candidate.

In cases of large documents unavailable as electronic files or which exceed the number of MB permitted for documents, applicants may submit these separately (in paper format or as a CD or DVD-ROM), accompanied by a detailed list of contents, by 2 p.m. of the deadline date for admission applications.

Any publications submitted on paper or digital support must be sent in a closed envelope, signed along the seal, to the following address:

Magnifico Rettore del Politecnico di Bari – Direzione Gestione Risorse e Servizi Istituzionali- Settore Ricerca, Relazioni Internazionali e Post-Lauream - Ufficio Protocollo – Via Amendola 126/B, 70126 BARI (Italy)

Envelopes must display the name and surname of the candidate together with the following text: "*Concorso di Ammissione al Corso di Dottorato in...* (name of the PhD programme)". The delivery of the envelope containing publications to Politecnico di Bari - by postal service, private courier or shipping agency - is at the exclusive risk of the candidate.

Admission examination

The admission examination is based on:

1. **an assessment of qualifications held** (average exam marks, final degree mark, theses, Master's degrees, post-graduate courses, language certification, publications, etc.);
2. **an interview** to ensure a complete evaluation of the candidate and to verify the applicant's aptitude for research and willingness to undertake experience abroad, as well as areas of research interest.

The Selection Board will assess candidates' qualifications and interview with a mark out of 100 (maximum mark for qualifications 40 and interview 60). Candidates obtaining less than 10 marks for the qualification evaluation will not be admitted to the interview.

The results of the Board's assessment for qualifications and project proposals will be published on the ESSE3 portal in the private area of each candidate.

No other notification will be sent directly to candidates.

At the end of the examination procedure, the Board will carry out an overall assessment and draw up an admission rankings list on the basis of the marks obtained by candidates in each part of the examination.

The assessment criteria for qualifications will be established by each Selection Board.

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UNIONE EUROPEA
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National Operational Programme 2014-2020 PhD programmes for sustainability and innovation-related subjects

**Ministerial DECREE N. 1061 (10 Aug 2021)
Academic Year 2021/2022 – XXXVII CYCLE**

INNOVATION-BASED TOPICS (ACTION IV.4) SCHOLARSHIP N. 11

A. RESEARCH PROPOSAL

Development of an innovative wearable system for the glucose monitoring

a. Relevance of doctorate research project in creating high added value in terms of scientific, social and economic impact on Italy, fostering appropriate research models and the formation of professional profiles as a response to the requirements of the business sector for innovation and competitiveness.

A development of research on topics of innovation, digital advancement and enabling technology while supporting the enhancement of human capital, determining factors in the progress of research and innovation in Italy.

According to the PNR and SNSI Italian initiatives, the topic “Health” opens up research and innovation challenges to reduce premature mortality due to the global increase of behavioral and non-behavioral risk factors, and chronic diseases. The paths in this area focus on the development of custom and multidisciplinary patient models, with a specific request for a shared and coordinated strategy between institutions and companies. The research activity in this area will have to prevent, cure, and improve the management of disease and the biomedical research will make available the results achieved by using innovative technologies. In this context, the research proposal aims at the study, design, and prototyping of an innovative system for the diagnosis of non-communicable diseases, as diabetes, which will involve about 700 million people by 2045, according to the International Diabetics Federation. This system will fulfil the requirements of next generation medicine, such as customization, non-invasiveness, and real-time diagnosis, by exploiting enabling technologies, as micro- and nano-electronics, photonics, plasmonics and intelligent data collection and analysis systems. Besides the remarkable economic and commercial impact of the proposed device, the added benefit is the advanced training of the Candidate who, during the PhD program, will have to face the problems related to non-communicable diseases and to design a biosensor compliant with the needs of the end user. The Candidate will have to test the effectiveness of the proposed system, taking also into account the prototype cost and its end users, as athletes or diabetic patients. The collaboration between universities and companies will lead to the formation of a “talent”, whose background will be used in several regional and national areas,

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through the acquisition of a professional profile that meets the demand of innovation and competitiveness of the industry.

b. Adherence of doctorate research project to National Strategies of Intelligent Specialisations (SNSI) and PNR and applicability to Law 240/2010 and Ministerial Decree 45/2013 regarding PhD students, with the aim of fostering innovation and exchange between the field of research and world of manufacturing and the certification of research project contributions within the sector of innovation (Law 240/2010, art. 24, section 3 and subsequent modifications and additions).

The proposed research activity aims at the study of an innovative and wearable biosensor to non-intrusively sense glucose in the human body. This research topic falls within the Subject Area *Health, nutrition, quality of life, E-health*, trajectory, *advanced diagnostics, medical devices and minimal invasiveness* of the Italian Initiative SNSI. The development of a sensor for detecting the presence of glucose turns out to be an efficient system for the diagnosis of non-communicable diseases, such as diabetes, which represents a significant epidemiological burden in the rich and industrial societies.

The design of a non-invasive biosensor meets the demands of the Italian initiative PNR (Health area, Pivot 3) that aim at reducing premature mortality due to non-communicable diseases. Different application scenarios can be also identified, such as the medical or sports field.

In particular, in the medical field, the detection of the amount of glucose in the blood is binding for the dosage of insulin in patients suffering from diseases, such as diabetes, aiming at developing a custom medicine. In sports field, the online measurement would allow the regulation of glucose present in the body, in order to optimize the athletic performance. The proposed system aims to overcome the limitations of invasive glucose sensors, currently on the market, by exploiting enabling technologies, such as micro- and nanoelectronics, photonics and plasmonics. The proposed system paves the way also to the non-invasive monitoring of other non-communicable diseases also through sustainable intelligent systems. The added value of the project is the interconnectivity of the system, able to interact with the user through a specific app designed to guarantee the best compliance and usability.

A strong collaboration between the universities and the company is required to meet the aforementioned goals, aiming at improving the innovation sector of the business companies. Since the envisaged activities will allow training a professional figure in the innovation context, they fulfill the claims of the Italian Law 240/2010 and Italian Ministerial Decree 45/2013 in the PhD area.

c. Research activity proposal, methods and contents

The proposed research activity consists of three phases: study (phase #1), design (phase #2), and prototype fabrication and testing (phase #3). During phase #1, solutions already on the market and/or proposed in the literature will be analyzed. Traditionally, the glucose monitoring is carried out by drawing blood or intrusive sensors that detect the amount of sugar in real time. This approach is invasive and is not easy to apply in several fields, such as athletics, where the control of the glucose within the range 50-200 mg/dl is necessary to optimize the athlete's performance. Recently, non-invasive sensors based on an electrical, with impedance reading, or optical approach, with the use of infrared rays or microwaves, have been proposed. The market and literature review will be useful to compare the features of the systems, currently in the market or under development, with the required performance, highlighting the performance gaps, in terms of accuracy and precision, as well as ease of use, lightness, flexibility and impact resistance.

The Candidate will have to design a new biosensor configuration, with a focus on the structure and functionality of the whole system, as well as the sensitive element based on innovative technology. A basic training on biology, anatomy and mechanics could be useful to carry out the design of the system. During the phase #2, the Candidate will have to design the sensitive element. In collaboration with the foreign university

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involved in the project, with consolidated experience in the biomedical sector, innovative technologies will be investigated for the fabrication of the biosensor, aiming at achieving an improvement of the state-of-the-art. The Candidate must also design the readout and interface electronics, in compliance with the safety regulations for the sensors, the mechanics of the prototype and the user frontend. The activities will be carried out in close collaboration with the company involved in the project. During phase #3, the system prototype will be assembled and tested. The measurements will be statistically analyzed to validate the results. A comparison with glucose meters already on the market and/or proposed in the literature will also be made to highlight the differences in terms of precision, accuracy, speed, ergonomics, usability, and ease of reading. The fabrication and characterization of the prototype in the phase #3 will allow to identify and solve problems that only the application context will be able to bring out. The reviews and the redesign of the prototype will also allow starting a first product engineering phase.

B. COMPANY-BASED ACTIVITIES within the Italian territory

a. Research activity to carry out with the company

By exploiting the company's background in the field of sensors and advanced electronic systems for Space and for high-tech applications, during the period that the Candidate should carry out at the company, he/she will first investigate the mechanics of the prototype. Furthermore, the Candidate will design the readout and interface electronics, manufacture and test the prototype. During the design activity, design to test, design to manufacturing and design to cost criteria will be adopted.

b. Period of company-based study and research

12 months

**c. Measurable nature of expected results and potential impact of implemented actions with reference to the aims of the Recovery Assistance for Cohesion and the Territories of Europe programme (REACT-EU):
quantifiable and measurable targets in doctoral research project in line with indicators set out in NOP reference of actions.**

The current COVID-19 pandemic has highlighted the need for reliable and accurate systems for controlling and monitoring the health of the population. The economic guidelines in recent years aim to invest resources in biomedical products and services, such as in the context of the European Regional Development Fund (ERDF) within the REACT-EU program. The proposed research concerns the innovation topic, using enabling technologies, and the enhancement of the human resources, aiming at offering a support to the economy and the health situation in our country. Ongoing and final results of the activities will be useful to assess the progress of the state-of-the-art in the field of wearable biosensors. In particular, the goals of the three phases foreseen during the research can be defined as follows:

- State-of-the-art of commercial and under development biosensors based on enabling technologies.
- Design of an innovative topology of wearable, of a non-invasive biosensor for glucose monitoring and of the sw supporting the system operation.
- Fabrication of the first prototype, including hardware and software, and testing of the innovative sensor prototype.

These goals meet the PON benchmarks, and they are easily measurable, in accordance with the aims of the actions of REACT EU.

The development of the proposed biosensor will require the merging of the know-how of the universities and companies involved in the research project. This partnership fulfils the # CO26 benchmark envisaged by

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Action 1.1.3 of the PON. A successful test of the device would lead to the introduction of the product in the production chain of the company, as aspired by the # 1b1 benchmark of Action 1.1.3 of the PON.

C. ACTIVITIES ABROAD

a. Research activity abroad

During the period abroad, the Candidate will have to study and investigate innovative technologies for the development of innovative biosensors. In particular, in collaboration with the host foreign University, which, boasts a high scientific expertise in the biosensor field, recognized by the international community, the Candidate must design the sensitive element, which represents the core of the device, as well as manufacture and characterize the prototypes. The Candidate will have to analyze the performance of the manufactured device and its compliance with the simulated ones. A redesign activity could be necessary.

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National Operational Programme 2014-2020 PhD programmes for sustainability and innovation-related subjects

**Ministerial DECREE N. 1061 (10 Aug 2021)
Academic Year 2021/2022 – XXXVII CYCLE**

SUSTAINABILITY-BASED TOPICS (ACTION IV.5) SCHOLARSHIP N. 12

A. RESEARCH PROPOSAL

Integration of the hydrogen vector in smart microgrids

a. Relevance of doctorate research project in creating high added value in terms of scientific, social and economic impact on Italy, fostering appropriate research models and overlap of knowledge and skills to promote the development of innovative products and services with reduced environmental impact, focusing on topics such as;

- protection of the ecosystem;**
- biodiversity;**
- reduction of climate change impact;**
- enhancement of sustainable development**

in order to promote green recovery and overcome the effects of the Covid-19 pandemic crisis.

The production, storage and subsequent use of green hydrogen represents one of the elements, perhaps the most important, for the energy transition process of our country in particular and of the entire industrialized world. In fact, the pushes towards the adoption and integration of this energy vector into the electrical systems by major industrial players and the world of national and European politics are important and consistent. The European Hydrogen Strategy and the national plans announced by some countries, including Italy, necessarily go through the creation of strong synergies between companies, institutions and the world of research. For Italy, for example, the strategy put into consultation in recent months provides for 5 GW of installed capacity for the production of green hydrogen and a first target of 2% of the energy mix by 2030, with an expected growth of up to 20% in the 2050. From the point of view of the world of research, a strong push towards these issues appears to be very necessary which, in addition to affecting merely technological aspects, will also have to invest aspects related to energy management in electrical systems with the ultimate aim of breaking down as much as possible the cost of hydrogen energy, in order to make it comparable

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	<p>with other energy carriers. In this sense, the integration of hydrogen in electricity grids in general and in smart microgrids in particular, the subject of the research proposed here, appears as a highly innovative element of certain interest in pursuing the aforementioned objectives of reliability and economy of the supply of energy to end users, or to create a high added value in terms of scientific, social and economic repercussions on the national and European territory. As proof of what has been said, the activity that the PhD student should carry out is part of the already outlined context of the ongoing collaborations on these issues with the companies involved in the project. Therefore, the interest of these major players in an effective technological transfer of scientific skills that will be acquired in close relationship between the scientific world, the business world and that of intergovernmental bodies is evident and immediate.</p>
<p>b. Adherence of doctorate research project to National Strategies of Intelligent Specialisations (SNSI) and PNR and applicability to Law 240/2010 and Ministerial Decree 45/2013 regarding PhD students and grant funding to Sustainability-based research projects.</p>	<p>The project proposal is fully part of the objectives proposed by the PNR. In fact, within the macro theme Industrial Energy - Articulation 1. Generation of energy from RES, energy storage and European and intercontinental networks, the proposed project fits well into the theme on the "development of national value chains for the production and use of electricity and hydrogen from RES, for energy storage, for power electronics and for energy management".</p>
<p>c. Research activity proposal, methods and contents</p>	<p>It is believed that with the integration of the hydrogen vector in the smart grid it is possible to produce green hydrogen at decidedly competitive costs compared to other possible solutions currently practicable. In fact, in such a system, and with the same efficiency of the technologies for the production of hydrogen, the reduction of the production cost shifts to the ability to develop new methods and algorithms capable of optimizing its production, pouring out the excesses of energy produced by wind and photovoltaic source towards an electrolyser and then towards an accumulation system. The subsequent utilization phase will be carried out through a fuel cell or, in a more convenient form, in blending with methane gas to feed the cogenerator and / or the microturbine. The research activity that any doctoral student should carry out will deal with the methodologies</p>

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	<p>for the optimal sizing of components (electrolyser, storage system, fuel cell and regulation systems for blending) and the development of algorithms for optimal system management. Attention will also be particularly focused on the problems of static and dynamic stability of the system, a problem already partially addressed with the company.</p> <p>The research will be divided into three phases: Phase 1: System integration in the Polytechnic of Bari; Phase 2: System implementation in the company Phase 3: Field implementation in a minigrid of a peacekeeping mission.</p>
B. COMPANY-BASED ACTIVITIES within the Italian territory	
<p>a. Research activity to carry out with the company</p>	<p>The involvement of the Polytechnic of Bari and the other companies is foreseen in each of the 3 phases in which the project is articulated. In addition to the main scientific task of his activity, the student will be required to interact with the different parties, without prejudice to the supervision of the tutor of the Politecnico. In this sense, strong interactions will be established between the Politecnico and the technical structures of the companies. In the first phase of System Integration at the Politecnico, even if physically the doctoral student will carry out his activity at the university, the meetings will be intense, even online with the other actors. Subsequently, for phases 2 and 3 of the project, the doctoral student will have to spend a period of not less than 6-8 months at the company.</p>
<p>b. Period of company-based study and research</p>	<p>6 months</p>
<p>c. Measurable nature of expected results and potential impact of implemented actions with reference to the aims of the Recovery Assistance for Cohesion and the Territories of Europe programme (REACT-EU): quantifiable and measurable targets in doctoral research project in line with indicators set out in NOP reference of actions.</p>	<p>It is proposed to adopt the number of publications in scientific journals or Conferences as an indicator of the expected results. Furthermore, technical-scientific reports will be defined for each phase of the project implementation</p>

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C. ACTIVITIES ABROAD	
a. Research activity abroad	Research activities abroad will focus on hydrogen development and its integration into microgrids in peacekeeping mission fields. At the moment there is no certainty on the actual possibility that such a mission could take place due to authorization problems related to safety.

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National Operational Programme 2014-2020 PhD programmes for sustainability and innovation-related subjects

**Ministerial DECREE N. 1061 (10 Aug 2021)
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INNOVATION-BASED TOPICS (ACTION IV.4) SCHOLARSHIP N. 13

A. RESEARCH PROPOSAL

a. Relevance of doctorate research project in creating high added value in terms of scientific, social and economic impact on Italy, fostering appropriate research models and the formation of professional profiles as a response to the requirements of the business sector for innovation and competitiveness.

A development of research on topics of innovation, digital advancement and enabling technology while supporting the enhancement of human capital, determining factors in the progress of research and innovation in Italy.

Cyber attacks on industrial reality represent a very important frontier issue in a era in which Industry 4.0 and its technologies are used massively in many productive contexts, often treating cyber security lightly.

HMI, PLC and SCADA could be also compromised from physical sources. For instance, ultrasound could be used to alter the classification result of an Artificial Intelligence algorithm applied within a sound recognition system; moreover objects of specific shape or appropriately directed light could affect the output of an algorithm applied to AR which estimates distances.

The attacker in advance often acquires information about the system and its functioning, trying to derive cause-and-effect related to commands, for example, by intercepting HMI inputs and outputs or by mapping the devices exposed to the network through commands of the most used protocols such as OPC. It is also easier to direct attacks knowing the characteristics of the measured variables within the monitored system.

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	<p>It would also be necessary to identify protections against Stealth Attack that could win against the protection guaranteed by anomalies reporting systems such as BDD (Bad Data Detection) or FDI (Fault Detection and Isolation).</p> <p>The protection of Operational Technologies (OT) it's still an underestimated topic, thus making control systems and related algorithms a very important subject of study.</p>
<p>b. Adherence of doctorate research project to National Strategies of Intelligent Specialisations (SNSI) and PNR and applicability to Law 240/2010 and Ministerial Decree 45/2013 regarding PhD students, with the aim of fostering innovation and exchange between the field of research and world of manufacturing and the certification of research project contributions within the sector of innovation (Law 240/2010, art. 24, section 3 and subsequent modifications and additions).</p>	<p>The aim of the research is to identify new forms of safety management, such as artificial intelligence algorithms and techniques which, applied to a productive context within intelligent factories, are able to recognize and validate the compliance of the collected data and determine if the information processed has been compromised or altered by disturbances in the vicinity of the data sources.</p>
<p>c. Research activity proposal, methods and contents</p>	<p>The proposed research is based on:</p> <ul style="list-style-type: none"> - the study of the current state of art regarding cybersecurity algorithms and techniques applied to Industry 4.0 world ; - analysis of the major vulnerabilities present in hardware/software systems currently in circulation; - analysis, design and implementation of a technology capable to monitor and research criminal actions, understand potential threats and create detailed reports on situation in real time. <p>The envisaged methodologies may be:</p> <ul style="list-style-type: none"> - theoretical and conceptual research; - literature review; - field investigations within manufacturing companies which implement I4.0; - development of a prototype. <p>The main contents of the research will focus on topics such as:</p> <ul style="list-style-type: none"> - analysis of industrial processes; - use of new technologies in the I4.0 field; - Industrial Control Systems (PLC, SCADA, HMI, IoT, etc.); - methods and best practices in the field of Cyber Security;

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	- Artificial Intelligence and Machine Learning algorithms.
B. COMPANY-BASED ACTIVITIES within the Italian territory	
a. Research activity to carry out with the company	<p>The activity involves the integration of the prototype into the pre-existing smart manufacturing platform system with the aim of enhancing the validation data process and strengthen it towards potential cyber attacks or flaws in the detection system used by ICS.</p> <p>Another objective of the research activity will be the creation of new machine learning models and algorithms capable to determine the truthfulness of the information acquired.</p> <p>This will be followed by a phase of testing and validation of the integrated solution in a real production context or within a simulated environment.</p>
b. Period of company-based study and research	12 months
c. Measurable nature of expected results and potential impact of implemented actions with reference to the aims of the Recovery Assistance for Cohesion and the Territories of Europe programme (REACT-EU): quantifiable and measurable targets in doctoral research project in line with indicators set out in NOP reference of actions.	<p>The efficiency of the proposed solution, objective of the research project, will be evaluated through the use of appropriate metrics to determine the performance of the same at the resolution of the security issues in a practical application within a productive context appropriately stimulated or, if a real process is unavailable, in a simulated environment.</p> <p>These metrics will be drawn from the best practices found in the scientific literature, in the case in which the algorithm belongs to already defined classification of AI and ML methodologies. Otherwise, the definition of appropriate KPIs will be part of the study itself of the PhD student.</p> <p>The objectives of this research project are perfectly in line with the aims of REACT EU, since knowledge in the Cyber Security field is strategic for safe application of innovative technologies even within production contexts and it's a catalyst for digitization processes, development and acquisition of skills, support for R&D processes.</p>
C. ACTIVITIES ABROAD	
a. Research activity abroad	Not applicable

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National Operational Programme 2014-2020 PhD programmes for sustainability and innovation-related subjects

Ministerial DECREE N. 1061 (10 Aug 2021)
Academic Year 2021/2022 – XXXVII CYCLE

SUSTAINABILITY-BASED TOPICS (ACTION IV.5)

SCHOLARSHIP N. 14

A. RESEARCH PROPOSAL

a. Relevance of doctorate research project in creating high added value in terms of scientific, social and economic impact on Italy, fostering appropriate research models and overlap of knowledge and skills to promote the development of innovative products and services with reduced environmental impact, focusing on topics such as;

- protection of the ecosystem;**
 - biodiversity;**
 - reduction of climate change impact;**
 - enhancement of sustainable development**
- in order to promote green recovery and overcome the effects of the Covid-19 pandemic crisis.**

The Ph.D. project "Digital energy systems for green energy communities" aims to train a figure of high scientific profile able to redefine, in a sustainable way, some of the central elements of modern cities, such as efficiency and energy saving, through the research and development of decision-making and control techniques for the so-called Energy Communities. Exploiting the potential of automation, information technology, and telecommunications, Energy Communities are an effective way of organization that citizens can adopt to respond collectively to some of their energy, social and environmental needs. This is consistent with the objectives of environmental sustainability and decarbonization that have been undertaken at the Italian and European levels.

Not surprisingly, the project idea is developed within a scientific and industrial sector, that is currently of great importance and in strong expansion, with significant scientific spin-offs and professional opportunities. In fact, the international context is moving not only towards a modernization of energy infrastructures according to the smart grid model but also towards a greater involvement of all the actors existing in cities and metropolitan areas, such as small and medium-sized users, on issues of energy efficiency and environmental sustainability. This represents the necessary factor to enable innovative actions aimed at fighting climate change as required by EU legislation but also to activate public and private investment in periods of economic stagnation.

This profound mutation has recently been emphasized by the Covid-19 pandemic. On the one hand, on a global level there has been a collapse in the demand for almost all fossil fuels,

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	<p>favoring renewable energies. On the other hand, new social practices are having non-negligible impacts on energy demand and consumption, requiring actions of coordination and collaboration for energy availability, energy security and energy justice, especially in less developed countries.</p> <p>In this context, the project idea, through real case studies, aims to address the energy transition goals. In order to be effective, cultural changes based on energy saving and consumption efficiency must be archived. In this scenario, the activation of new forms of collective action and collaborative economies, combined with the opportunities offered by digital technologies, are the key points of the energy transition, as well as representing an opportunity for the creation of new green economies.</p>
<p>b. Adherence of doctorate research project to National Strategies of Intelligent Specialisations (SNSI) and PNR and applicability to Law 240/2010 and Ministerial Decree 45/2013 regarding PhD students and grant funding to Sustainability-based research projects.</p>	<p>The topic of the Ph.D. project "Digital Energy Systems for Green Energy Communities" is perfectly integrated with the research and development strategies carried out at the national and international levels, which are undergoing radical transformations, enabled by the progressive and pervasive adoption of digital technologies, and by the integration of storage technologies and renewable sources.</p> <p>From the perspective of the European Green Deal, there are many opportunities that Digital Energy offers to the actors involved in the energy system. The general approach focuses on the end-customer and defines a virtuous incentive system that defines the perfect combination between making business and obtaining economic, environmental, and social benefits for all stakeholders. In this context, the project idea consists of the development and application on urban areas of ICT technologies, to support self-consumption architectures and energy communities, and to help community users to save and consume energy more efficiently and intelligently.</p> <p>From the point of view of SNSI, the project idea combines the areas of specialization of "Energy" and "Smart, Secure and Inclusive Communities". In particular, referring to technological solutions for the realization of innovative models integrated into the sustainable and green management of metropolitan areas, the research activities are connected to the priorities of the PNR related to "Intelligent, flexible, integrated, resilient and digitized networks for a full integration of RES" and "Buildings, storage, and interaction with energy communities and smart energy grid".</p> <p>In addition, the objective of the proposed research project has a strong multidisciplinary character and refers to all scientific areas involved in the definition of</p>

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	<p>a smart grid in order to activate processes essential for a green energy transition. Therefore, in accordance with L.240/2010 and DM 45/2013, the research topic is central for the Ph.D. Program in Electrical and Information Engineering whose purpose is to provide Ph.D. students with a training of high scientific quality in research topics ranging from Electrical Engineering and Information Engineering. The study and research activities of the Ph.D. student during the three years will be constantly supervised by a university professor; the Ph.D. student will also be tutored by partner supervisors.</p>
c. Research activity proposal, methods and contents	<p>The Ph.D. project "Digital energy systems for green energy communities" consists of the development and application on urban areas of ICT technologies, to support self-consumption architectures and energy communities, that help community users to save and consume energy more efficiently and intelligently.</p> <p>To fully capture these sustainability goals, new hierarchical/decentralized/distributed control algorithms will be defined, simulated, and tested for optimal scheduling electrical devices owned by prosumers in an energy community, in both planning and real-time fashions. The use of these methodologies, highly innovative in the field of automation, optimally allows managing the smart grid with profit for the users and benefits for the environment, thanks to the reduction of consumption and emissions. The originality of the project lies in the integration of heterogeneous data from various users, on different spatial and temporal scales, to provide an overview of the entire network. The development of these algorithms will take into account key aspects such as scalability and privacy in large-scale contexts (with hierarchical/distributed control techniques and game theory) and sources of uncertainty (such as quantity and behavior of occupants, and meteorological factors), as well as innovative aspects such as mathematical modeling of user preferences and shared management of devices such as energy storage systems (which for logistical and economic reasons can not be installed by individual users).</p> <p>The three-year research work will be divided into the following phases. In the first phase, the paradigm of the energy community, as well as the national and international regulatory framework will be deeply investigated. Through in-depth analysis of the state of the art, different possible models of energy communities will be identified. In the second phase, appropriate decision and control algorithms will be defined for the optimal energy scheduling of strategies and cooperation mechanisms within an energy community, with particular reference to the management of shared resources. In the third phase, the algorithms will be validated on realistic scenarios in urban areas. As a last step, the</p>

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	<p>potential effects on the regional and national system will be examined, as well as the real development prospects in the energy community market and the business opportunities for utilities, retailers, energy service companies, technology providers.</p>
<p>B. COMPANY-BASED ACTIVITIES within the Italian territory</p>	
<p>a. Research activity to carry out with the company</p>	<p>Although there is a fair amount of research regarding collective self-consumption and energy communities, the various current actions are often aimed at demonstrating, in well-defined architectures and on well-defined areas, their potential as a social transformer in the adoption of eco-sustainable behaviors. The effective realization of these objectives can only pass through the availability of technological devices able of making more advanced energy management at a larger scale automating virtuous behaviors such as self-consumption. It is therefore essential to strengthen the industrial development in this area, so far not fully explored, in order to achieve communication systems scalable, interoperable, and secure. Finally, given the multiplicity of implementable configurations of collective self-consumption and energy community, the innovativeness of the project idea lies in the development and implementation of monitoring systems and management of new energy architectures with IoT multi-protocol devices, intelligent and highly flexible.</p> <p>For the above reasons, the research activity at the company will deal with the definition and development of devices that control the energy flows the generation and storage. The core components of such intelligent devices will be</p> <ul style="list-style-type: none"> - decision and control algorithms for maximizing self-consumption and managing the charging/discharging of BESS to minimize the amount of electricity injected into the grid; - blockchain applications that record, energy "transactions" for the purpose of profit-sharing within the community. <p>For these reasons, the proposed Ph.D. project will take advantage of the collaboration with the company. The collaboration takes advantage of an established partnership between the company and the proposing research group in several research projects. The company will contribute to the project activities by providing the Ph.D. student with its know-how in modeling and control of electrical networks. The company will also make available to the student (who will have a company tutor) some of its equipment to achieve the objective.</p>
<p>b. Period of company-based study and research</p>	<p>6 months</p>
<p>c. Measurable nature of expected results and potential impact of</p>	<p>Concerning the aims of the PON-REACT-EU, the Ph.D. project "Digital energy systems for green energy</p>

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<p>implemented actions with reference to the aims of the Recovery Assistance for Cohesion and the Territories of Europe programme (REACT-EU): quantifiable and measurable targets in doctoral research project in line with indicators set out in NOP reference of actions.</p>	<p>communities" will mainly affect the indicator "R3.3: Participants involved in research projects activated on Green and Innovation topics with the support of REACT EU on the total number of subjects involved in research projects". In addition, the Ph.D. project will have positive impacts on program-specific output indicators, increasing by one unit the value of each of the following two indicators: "CO11: Holders of tertiary education ISCED 5 to 8" and "CO26: Number of enterprises cooperating with research institutions". In detail, the following describes the potential impact of the results of the research project on the entire socio-economic-industrial system and/or with territorial policies and the connections that can be activated with the productive system and other public-private actors.</p> <p>The Ph.D. project exploits ICT to increase the involvement of urban actors (primarily citizens and small /medium users) for energy efficiency and environmental sustainability. Thanks to the innovative actions -according to the international scientific community and EU regulations- the scientific impact will be very significant for the energy-environment sector. This impact will be measured through the number of scientific contributions published in proceedings of conferences of an international level (expected number: 6) and international journals (expected number: 3). Moreover, the result will be evaluated through the activation of a number of collaborations (expected number: 3) with technology providers for products and services for the optimal management of distributed energy resources and with public-private laboratories operating for the development of small cogeneration plants with storage systems, as well as with major European universities.</p> <p>Finally, since the project idea is of great relevance for the Apulia region (in first place in Italy for energy production from renewable sources and promotion of efficiency programs), benefits are expected to all actors of the regional energy community. These benefits can be measured through the reduction of CO2 caused by the experiments anticipated in the project and by the number of products, developed by the partner company, on which the level of technological maturity will be increased by at least one unit.</p>
<p>C. ACTIVITIES ABROAD</p>	
<p>a. Research activity abroad</p>	<p>The research activities carried out abroad (for a period of 6 months) will focus on the definition and development of intelligent systems for the management and control of energy devices shared by the users of an energy community. The most common example refers to energy storage systems, which for logistic-economic reasons cannot be installed individually by small and medium size users.</p>

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Shared energy storage systems represent one of the recent advanced smart grid technologies that provide distribution networks with numerous advantages in terms of stability, reliability, quality and control. Shared storage systems are cost-effective not only from the users' perspective. Shared storage systems are typically located at the edge of the grid (rather than at the distribution substation), close to customers and distributed generation sources, providing effective action in mitigating the impacts of intermittent energy sources or other smart grid components (such as electric vehicles) and in helping integrate these devices into the distribution grid. The main concept of shared storage, initially used in medium/high voltage substations, in recent years has become more applicable on the customer side for the peak shaving, (shifting/leveling of demand/generation profiles), power quality improvements (voltage and reactive power support), frequency regulation, etc. However, the effective integration of shared storage systems is not immediate due to technological barriers caused by the complexity of the infrastructure. Above all, the lack of efficient control technologies has so far prevented the diffusion of these innovative systems on a large scale or to the energy community market.

To overcome these limitations, the research activities carried out abroad will aim to define and validate control algorithms, reliable and performing both in planning and in real-time, with which multiple users, located in a given urban area can share flexibly and efficiently resources. The project will take advantage of the collaboration with partner, which conducts cutting-edge research aimed at defining efficient methodologies to coordinate large-scale energy systems. In particular, the proposed collaboration exploits a pre-existing partnership on the analysis and control of complex, multi-agent, cooperative, non-cooperative, and mixed systems.

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UNIONE EUROPEA
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National Operational Programme 2014-2020 PhD programmes for sustainability and innovation-related subjects

Ministerial DECREE N. 1061 (10 Aug 2021)
Academic Year 2021/2022 – XXXVII CYCLE

INNOVATION-BASED TOPICS (ACTION IV.4)

SCHOLARSHIP N. 15

A. RESEARCH PROPOSAL

Digital Ledger Technologies for semantic-based cyber-physical systems

a. Relevance of doctorate research project in creating high added value in terms of scientific, social and economic impact on Italy, fostering appropriate research models and the formation of professional profiles as a response to the requirements of the business sector for innovation and competitiveness.

A development of research on topics of innovation, digital advancement and enabling technology while supporting the enhancement of human capital, determining factors in the progress of research and innovation in Italy.

The study and research topics outlined in the project proposal are consistent with the disciplinary areas of the PhD in Electrical and Information Engineering. In particular, the Ph.D. program is strongly characterized by Big Data methodologies and applications, Sensor Networks and the Internet of Things, Artificial Intelligence and Machine Learning, Cybersecurity, Intelligent Transportation Systems and Smart Grids, only to mention the most relevant areas.

The proposed research has a high level of innovation thanks to its focus on cutting-edge technologies, based on Digital Ledger Technologies (DLTs) and blockchain, for the management of pervasive distributed transactional systems.

The application scenarios in which the proposed research will be tested mainly concern production systems and supply chains. In these application scenarios, it is planned to leverage the paradigms of Artificial Intelligence and Machine Learning in the automated management of processes, thanks to the support of enabling technologies such as the Internet of Things. Another important aspect considered in the proposal is the analysis of Big Data related to the data streams monitored by sensor networks. Finally, the research plans to exploit DLTs to optimize security management in information access. Based on these considerations, the complete correspondence of the

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	<p>issues to be addressed with respect to the above topics of the Ph.D. program is evident.</p> <p>Therefore, the results of the research will have scientific, social and economic implications, facilitating the technology transfer of methodologies and tools to promote innovation and competitiveness of the entrepreneurial fabric in the territory, as well as the training of the following professional profiles:</p> <ul style="list-style-type: none">- researchers at public and private research institutions, or at Italian and foreign universities;- researchers working in Small-Medium Enterprises (SMEs);- professional consultants in the specific sector of DLT and blockchain;- experts in the proposed research areas. <p>Furthermore, this proposal aims to combine research activity in the area of advanced technologies of Electrical and Information Engineering, with reference to the specific needs of the territory and Southern Italy.</p>
<p>b. Adherence of doctorate research project to National Strategies of Intelligent Specialisations (SNSI) and PNR and applicability to Law 240/2010 and Ministerial Decree 45/2013 regarding PhD students, with the aim of fostering innovation and exchange between the field of research and world of manufacturing and the certification of research project contributions within the sector of innovation (Law 240/2010, art. 24, section 3 and subsequent modifications and additions).</p>	<p>The research proposal focuses on the study and testing of innovative models, architectures and algorithms for distributed and pervasive cyber-physical systems, through the integration of knowledge representation technologies and automated reasoning with blockchain-based transactional systems.</p> <p>A blockchain is made up of a set of actors connected in a peer-to-peer network, which exchange digital information and certify it by solving an algorithm.</p> <p>In the industrial automation scenario, one of the applications of the proposed research may concern the development of an innovative system to manage the coordination and scheduling of tasks automatically by the agents in a manufacturing plant.</p> <p>Based on these considerations, the research topic is consistent with the "Smart and sustainable industry, energy and environment" area envisaged by the National Strategy for Intelligent Specialization, as the achieved objectives and results will be applicable to the creation of innovative, highly efficient production processes, for industrial sustainability and evolutionary and adaptive manufacturing systems for customized production.</p> <p>The second scenario covered by the research proposal concerns supply chains. In this context, the objective of the research proposal is to improve the efficiency and traceability of information related to the production chain through DLTs, by exploiting the paradigms of Artificial Intelligence and automated</p>

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	<p>reasoning techniques. Based on these features, the scenario is consistent with the "Digital Agenda, Smart Communities, Intelligent Mobility Systems" area, with respect to the "Intelligent urban mobility systems for logistics and people" development trajectory.</p>
c. Research activity proposal, methods and contents	<p>Distributed Ledger Technologies (DLTs) are a research and application area of growing interest. They inherit architectural paradigms from distributed databases, integrating principles drawn from peer-to-peer networks and cryptographic technologies, in order to support secure transactional collaboration between independent nodes without resorting to a centralized intermediary authority or mutual trust relationships among participants.</p> <p>DLTs can be applied to pervasive Cyber-Physical Systems (CPSs), i.e. computer systems that, on one side, cooperate with each other through mobile and ad-hoc network connections for data access and processing, while on the other side they interact with the physical world and human users. In order to improve the performance and expand the functionality of DLT in CPS, the research proposal aims to integrate studies and results of knowledge representation and automated reasoning. A possible approach involves the evolution of a DLT platform into a Service-Oriented Architecture (SOA), in which semantic-based resource discovery processes are applied to the assets stored in the ledger, using techniques and technologies mutated from the Semantic Web. This approach represents an evolution towards the so-called Semantic Web of Things (SWoT), which purports the adoption of semantic-based pervasive computing, by integrating intelligence both in objects and in the environment through the dissemination of a large number of micro-devices, each conveying a small fragment of annotated information with respect to a formal ontology.</p> <p>In particular, the proposal aims to introduce, study, analyze and experimentally evaluate an innovative architecture for DLT from a functional and performance point of view, which sees the introduction of a semantic layer. This allows envisaging a series of new and possible applications for the Web of Things which, while benefiting from the flexibility and pervasiveness of the IoT, do not have to give up strong security and trust guarantees. A possible strategy that will be studied in this proposal is to extend the solutions based on DLT, and in particular on blockchain, by running Smart Contracts</p>

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	<p>(SCs) enabled for automated reasoning on the basis of annotations stored in the distributed ledger. By means of a semantic layer it will be possible to perform operations implemented as SCs, executed in a distributed way and validated by means of a consensus algorithm. To this end, the proposal intends to investigate the support of SCs for managing the registration of assets, the discovery and explanation of results, but also for automatic execution of more complex service composition and substitution tasks.</p>
B. COMPANY-BASED ACTIVITIES within the Italian territory	
a. Research activity to carry out with the company	<p>The company carries out research and development activities on an ongoing basis in technologically advanced areas, such as the industrial sector and the emerging fields of the Internet of Things.</p> <p>In this business context, the Ph.D. candidate will carry out research on the innovative technology of semantic-based DLTs, focusing activities on innovative solutions for smart manufacturing and supply chain management.</p> <p>An important issue that hinders the automatic management of systems of autonomous software agents in manufacturing processes is the problem of organizing a workload in a multi-agent scenario. In the industrial automation scenario, the goal is to have agents of a manufacturing plant manage task coordination and scheduling automatically. The research activity to be carried out will involve the development of a prototype solution that will allow semantic enrichment and the improvement of the interoperability levels among agents in a highly dynamic and unpredictable context.</p> <p>Many companies have resorted to automation and Internet of Things technologies, however, the amount of monitored data makes it difficult to extract resource information in a timely fashion, and also implies higher costs and greater security risks. DLTs can improve efficiency and traceability thanks to the ability to guarantee reliability, robustness and security. For example, blockchain technology can be integrated with the use of IoT devices for the implementation of advanced services and to improve transparency by increasing resilience to failures or malicious attacks, and therefore reliability. This goal can be achieved by virtue of the introduction of the proposed semantic layer. Each agent can be modeled through a DLT or blockchain node, which can share assets with other nodes in the network. Furthermore,</p>

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	<p>each specific task offered by one or more agents can be modeled as an additional asset, endowed with a semantic-based annotation. For example, for each task, the preconditions necessary to start its execution and the effects it produces upon its end can be annotated, as well as contextual information, such as the unit production cost.</p> <p>The ultimate goal of this research is the creation of a dynamic mechanism through which thousands of "untrusted" parties combine to create a reliable and irrevocable set of information records which keeps growing, resisting to any tampering.</p> <p>The research activities to be conducted at the company will therefore be aimed at assessing the feasibility of the semantic-enhanced DLT approach and the scalability of the architecture.</p>
b. Period of company-based study and research	6 months
c. Measurable nature of expected results and potential impact of implemented actions with reference to the aims of the Recovery Assistance for Cohesion and the Territories of Europe programme (REACT-EU): quantifiable and measurable targets in doctoral research project in line with indicators set out in NOP reference of actions.	<p>The inclusion of the Ph.D. student in a working group supporting innovation on issues related to Artificial Intelligence, IoT, CPS and DLT, will increase the student's skills and will direct them towards future technologies that companies take into consideration in their digital transformation process. These skills will contribute to increasing the student's competitiveness in the workplace.</p> <p>In particular, the research proposal envisages the creation of one or more frameworks based on DLT and blockchain, which will integrate the envisaged technological innovations, that is a semantic-based extension to provide advanced discovery and orchestration capabilities on services and tasks of a complex process.</p> <p>To this end, the research activity carried out at the company will involve the creation of a testbed for the verification and experimental analysis of the proposed solutions. In particular, experimental tests will be performed on the frameworks, and collected results will be carefully analyzed to obtain a confirmation of the potential of the implemented approaches.</p> <p>Each tangible result, deriving from the research in the various phases envisaged by the proposal, will be consolidated through publications in scientific journals or presentation at international conferences. There will also be training opportunities for staff within the host company, so that the knowledge</p>

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	<p>developed by the recipient of the scholarship is acquired permanently and integrated into the company's business processes. Analyzing the possible applications of the proposed research, the results obtained may be showcased to companies operating in the various sectors of economic activity which use smart technologies requiring secure information transmission and storage. Following this approach, exponential growth is expected in the worldwide market, with a compound annual growth rate of over 10%. The extent of the impact in terms of employment effects is clearly evident.</p> <p>From what has been said it is therefore evident that all the conditions exist for the subsequent employment at regional, national or European level of the doctoral student involved in this project.</p> <p>Based on these considerations, with reference to the purposes of REACT EU, it is possible to identify the correspondence of the above proposals and research goals with the objectives envisaged for the investments allocated by the European Regional Development Fund (ERDF), in particular on the specific “ICT Services & applications dimension. for SMEs (082)” and “ICT: Other types of ICT infrastructure (048)” axes. Among the investment areas envisaged by ERDF, the categories of “Business support” and “Research and innovation” are certainly relevant.</p>
C. ACTIVITIES ABROAD	
a. Research activity abroad	Not expected.

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National Operational Programme 2014-2020 PhD programmes for sustainability and innovation-related subjects

Ministerial DECREE N. 1061 (10 Aug 2021)

Academic Year 2021/2022 – XXXVII CYCLE

SUSTAINABILITY-BASED TOPICS (ACTION IV.5)

SCHOLARSHIP N. 16

A. RESEARCH PROPOSAL

a. Relevance of doctorate research project in creating high added value in terms of scientific, social and economic impact on Italy, fostering appropriate research models and overlap of knowledge and skills to promote the development of innovative products and services with reduced environmental impact, focusing on topics such as;

- **protection of the ecosystem;**
- **biodiversity;**
- **reduction of climate change impact;**
- **enhancement of sustainable development in order to promote green recovery and overcome the effects of the Covid-19 pandemic crisis.**

The PhD program is based on the combination of two fields: renewable energy and Unmanned Aerial Vehicle (UAV). Among renewable energies, photovoltaic and wind systems are promising energy sources for achieving the goals set in the 2015 Paris Agreement (COP21), briefly described as follows: a) to avoid dangerous climate change by limiting warming global below 2°C; b) to continue efforts to limit it to 1.5°C; c) to strengthen the ability of countries to deal with the impacts of climate change. To these objectives the national ones are added, such as the Italian PNIEC (Integrated National Plan for Energy and Climate 2030).

The advantage of these two technologies over the others include:

- technological maturity;
- wide commercial diffusion;
- grid parity already achieved in 2013;
- modularity of the systems, which allows their use from small (500W) to large (100MW) power;
- widespread skills in development, design, implementation and management of the projects and construction sites;

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	<ul style="list-style-type: none">• diffusion, for photovoltaics, of solutions applied to buildings (BAPV) or integrated in them (BIPV);• widespread use of pilot projects to improve energy efficiency, using new materials (e.g. perovskite) or new solutions (double-sided modules, floating systems for photovoltaics or off-shore for wind power);• etc. <p>Alongside these issues, there is the need to monitor the proper functioning of electrical systems both for the rapid identification and classification of faults and for the evaluation of energy performance, because these systems must operate for several decades. To this end, telemetry sensors, also based on IoT, are a first warning system, but human final check is required for the decision on restoration. In this case, the use of UAS (drone, control system and payload) can make interventions safer (e.g. for workers at height for checking wind systems), analyzes faster (a drone reaches the top of a wind tower in a few seconds and supervises a photovoltaic system in a much shorter time than that necessary for a man), the work activity more stimulating, because it also requires the skills to pilot the drone.</p> <p>This contamination of knowledge and the use/development of innovative products and solutions require a high added value for both operators and their supervisors.</p>
b. Adherence of doctorate research project to National Strategies of Intelligent Specialisations (SNSI) and PNR and applicability to Law 240/2010 and Ministerial Decree 45/2013 regarding PhD students and grant funding to Sustainability-based research projects.	<p>The PhD program is based on two areas: renewable energy and UAS. The topic of renewable energy is widely present in section 5.5 CLIMATE, ENERGY, SUSTAINABLE MOBILITY of the NRP and, specifically, on the axis of industrial energy.</p> <p>Renewable energies are considered among the technologies that can contribute to the reduction of climate-altering emissions and the reduction of industrial costs. They also appear in the SNSI specialization areas under 5.3.7 ENERGY and 5.4.2 INTELLIGENT AND SUSTAINABLE INDUSTRY, ENERGY AND ENVIRONMENT. In general, the SNSI declares that the energy area has very strong integrations with all the other areas of specialization.</p>

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	<p>The second area of the doctoral course concerns the use of UAS, present in SNSI, axis 5.3.2 AEROSPACE, and in PNR, axis 5.4.7 AEROSPACE.</p> <p>Both themes are of great interest to the industrial sector, which includes numerous active companies, as reported in the SNSI.</p> <p>The PhD program will also make use of the participation of a company which deals with video streaming. The PhD student, during the period he will spend in the company, will acquire skills in the processing of videos acquired with drone, and, at the same time, will be able to transfer skills to the diagnostic aspects of renewable energy plants.</p>
<p>c. Research activity proposal, methods and contents</p>	<p>The efficiency of commercial photovoltaic (PV) modules varies from 8% to 30%, depending on the semiconductor material (amorphous, organic, silicon-based or perovskite) and the manufacturing technology. Power losses indicate internal cell problems or problems due to production and manifest themselves as the operating temperature increases. Fault detection and diagnostics allow you to maximize electricity production. To this end, infrared (IR) analysis techniques are commonly used to check for typical defects in photovoltaic modules; however, the infrared thermograms or videos are not sufficient to extract all the information useful for module diagnostics.</p> <p>The size of the PV plant to be supervised and the difficulty of accessing it are further parameters to consider. A photovoltaic system is generally considered large if it occupies more than one hectare or when the peak power is equal to or greater than 1MWp (consisting of over 5,000 modules). A photovoltaic system is considered difficult to access if the inspection is difficult, such as when photovoltaic systems are placed on the roof of commercial/industrial buildings. In these cases, an IR analysis with a portable IR camera, managed by one or more operators, is not possible or is not efficient from a time point of view. In these cases, it may be useful to exploit innovative technologies such as remotely piloted systems, known as Unmanned Aerial System (UAS), equipped with high-resolution thermal imaging cameras.</p>

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	<p>Diagnostic analysis using UAS is more complex than manual one, both for the necessary drone piloting skills and for the implications of the different reciprocal drone-module position. Even if acquisition times are reduced, the complexity related to the correct diagnostic interpretation of the thousands of thermograms are not eliminated. On this topic, the PhD student will deal with the examination of the possible causes of the defect and the realization of diagnostic algorithms, which allow the correct classification and rapid identification of the defect in a quasi-automatic way.</p> <p>These approaches concern single modules or arrays of PV modules. However, sometimes the losses are due to other parts of the system (cables, diodes, inverters, transformers, junction boxes, etc.), which can also be monitored with infrared technologies, even without UAV.</p> <p>UAS are also very useful for monitoring wind systems, for large ones. Some known problems (mechanical cracks, ice formation, etc.) require visual inspection, to assess their criticality. In these cases, the use of drones would make it possible, by limiting the exposure of workers to situations at greater risk.</p>
B. COMPANY-BASED ACTIVITIES within the Italian territory	
a. Research activity to carry out with the company	<p>The PhD program involves the processing of infrared videos acquired with the aid of a drone. These videos may relate to photovoltaic modules or, alternatively, other components of photovoltaic systems, and parts of wind power plants (blades, tower, electrical components inside the nacelle). The videos, for diagnostic purposes, need both a good acquisition and a correct interpretation.</p> <p>These research aspects will be carried out within the company, where the PhD student will acquire the technical skills necessary for the acquisition of the videos, in addition to the skills for video processing and the creation of algorithms for the automatic classification of detected defects.</p>
b. Period of company-based study and research	6 months

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<p>c. Measurable nature of expected results and potential impact of implemented actions with reference to the aims of the Recovery Assistance for Cohesion and the Territories of Europe programme (REACT-EU):</p> <p>quantifiable and measurable targets in doctoral research project in line with indicators set out in NOP reference of actions.</p>	<p>Proposal is to adopt the number of scientific publications on journals or Conferences as an indicator of the expected results.</p>
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