Call for applications for admission to XXXVIII Cycle of Politecnico di Bari PhD Programmes

Attachment 7

JOINT PhD PROGRAMME IN

SUSTAINABILITY ENGINEERING AND SAFETY IN CIVIL & INDUSTRIAL BUILDINGS

Inter-university course in collaboration with Università del Salento, Institute of Construction Technology and National Research Council (ITC-CNR)

Project Identification Code (CUP): D93C22000570001; D93D22001380001

XXXVIII CYCLE DOCTORATE PROGRAMME PROFILE	
DEPARTMENT	Department of Civil Engineering and Architecture Sciences
COORDINATOR	Prof. Mario Daniele Piccioni (mariodaniele.piccioni@poliba.it)
PLACES AVAILABLE	6 *(1 of which with grant reserved for graduates from non-Italian universities)*
of which	
*Places with **Politecnico di Bari** grant*	1
*Places with **Poliba** grant funded by NRRP – as per Ministerial Decree **351/2022*** *__Refer to research topic list below__*	1 GRANT N. 1 - **Area**: Public Administration; **Topic**: "*Energy recovery systems and modelling for sustainable urban clusters and energy communities*".
*Places with **Poliba** grant funded by NRRP – as per Ministerial Decree **352/2022*** *__Refer to research topic list below__*	1 GRANT N. 2 - **Co-funded by**: CAV s.r.l.; **Topic: "***Development of new pre-mixes for eco-sustainable construction obtained from re-use of waste plastics*".
*Places with **Unisalento** grant funded by NRRP – as per Ministerial Decree **352/2022*** *__Refer to research topic list below__*	1 GRANT N. 3 - **Co-funded by**: I-AM s.r.l.; **Topic: "***Methods and tools for the management of complex infrastructures*".
*Places with **ITC-CNR** grant*	1
Places without grant funding	1
ADMISSION REQUIREMENTS *Applicants to the PhD programme in Sustainability Engineering and Safety in Civil & Industrial Buildings **must hold a second level (specialized) degree***	*Master's Degrees* ➢ LM-4 Architecture and Building Engineering; ➢ LM-10 Architectural and Environmental Heritage Conservation; ➢ LM-11 Science of Cultural Heritage Conservation; ➢ LM-20 Aerospace and Astronautical Engineering; ➢ LM-23 Civil Engineering; ➢ LM-24 Building Systems Engineering; ➢ LM-26 Safety Engineering; ➢ LM-28 Electrical Engineering; ➢ LM 29 Electronic Engineering; ➢ LM-30 Energy and Nuclear Engineering; ➢ LM-31 Management Engineering; ➢ LM-32 IT Engineering; ➢ LM-33 Mechanical Engineering; ➢ LM-34 Naval Engineering; ➢ LM-35 Environmental and Land Engineering; ➢ LM-44 Mathematical-Physical Modelling for Engineering;

	Specialized Degrees
	➢ 4/S Architecture and Building Engineering;
	➢ 10/S Architectural and Environmental Heritage Conservation;
	➢ 12/S Conservation and Restoration of Historical and Artistic Heritage;
	➢ 25/S Aerospace and Astronautical Engineering
	➢ 28/S Civil Engineering;
	➢ 31/S Electrical Engineering;
	➢ 32/S Electronic Engineering;
	➢ 33/S Energy and Nuclear Engineering;
	➢ 34/S Management Engineering;
	➢ 35/S IT Engineering;
	➢ 36/S Mechanical Engineering;
	➢ 37/S Naval Engineering;
	➢ 38/S Environmental and Land Engineering;
	➢ 50/S Mathematical-Physical Modelling for Engineering;
	➢ Degree qualifications awarded by foreign universities officially recognised as equivalent to the above degrees [1].

APPLICATION PROCEDURES
Please note that the information provided below complements and does not substitute that contained in arts. 2 and 3 of the general Application Call.

| 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***.* | ➢ **A CV** following the layout of the example provided by Politecnico di Bari at https://www.poliba.it/it/dottorati-di-ricerca.

(File to be named "01.CV").

➢ **Copy of a current identification document**. Only the following documents will be considered eligible:
 • ID cards issued by an EU member state;
 • driving licence issued by an EU member;
 • in all other cases, a full validity passport (also non-EU citizens).

(File to be named "02.Documento Riconoscimento").

➢ **Degree qualification certification for first (Bachelor's) degrees and second (specialization/Master's) degrees (or 5-year Single Cycle degrees)**.

Candidates with qualifications awarded in Italy <u>must</u> attach the Politecnico form available at https://www.poliba.it/it/dottorati-di-ricerca, specifying:
 • final degree mark;
 • a list of all exams taken with their relative marks in both degree courses (or the Single Cycle course);
 • results of exams taken.

(File to be named "03.Titoli di Laurea"). |

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[1] *Where a qualification awarded by a foreign university has **not yet been declared equivalent** to an Italian university degree, subject to verification by the administration offices, the Selection Committee will decide upon the eligibility of the foreign qualification in line with current Italian regulations and those of the country of origin, as well as any international treaties or agreements on qualification recognition for further study.*

Candidates with a degree qualification awarded by a non-Italian university must attach the following documents to their application, as issued by the awarding body. This supersedes any form of self-declaration [2]:

- 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.

(File to be named "03.Titoli di Laurea").

➢ **An abstract 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).

(File to be named "04.Abstract Tesi").

➢ **Candidate 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 as completed 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.

(File to be named "05.Tesi")..

➢ **PhD research** proposal which the candidate intends to develop during the programme, stating the scientific basis of the proposal, its research objectives and the methods to be used. Research proposals and projects are assessed purely for the purposes of admission and are not necessarily those which the candidate will follow during the programme

Research proposals must use the format available at the following link (title "*ALLEGATO G_FORMAT PROPOSTA DI RICERCA_DRISS.doc*"):
https://www.poliba.it/sites/default/files/dottorati/allegato_g_format_proposta_di_ricerca_driss_english.docx

N.B: Candidates who intend to propose a research project based on the topics set out in Ministerial Decrees 351/2022 and

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[2] **N.B.**: 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 2022/23*" available at the Ministry link https://www.studiare-in-italia.it/studentistranieri/*"..

	352/2022 must prepare a proposal in line with one or more of the topics listed below. *(File to be named "06.Proposta di Ricerca").*
OPTIONAL DOCUMENTATION	➤ **A self-certification declaration for any other qualifications** deemed suitable for evaluation which must be signed and dated (following the layout of the example provided at https://www.poliba.it/it/dottorati-di-ricerca), as per arts.46 and 47 of Presidential Decree n. 445/2000. *(File to be named "07.Dichiarazione altri titoli").* ➤ **Either one or two letters of reference from teaching staff** who have supervised the candidate throughout their university-level studies. *(Files to be named "09.Lettera presentazione 1", "08. Lettera presentazione 2").* ➤ **Language certification** demonstrating a knowledge of English which corresponds to at least B2 level. Only those candidates who are non-Italian citizens may attach certification which demonstrates knowledge of the Italian language. *(File to be named "09.Certificazione linguistica 1"; etc).* ➤ **Any publications** related to activity carried out and shown on the candidate's CV. These must be in either Italian or English or translated into Italian or English on behalf of and under the responsibility of the candidate. In cases of **large publications** unavailable in electronic format 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), together with a detailed explanatory list, by 2 p.m. on the deadline date for applications. All publications submitted on paper or on electronic media must be sent in a sealed envelope, signed along the flap, 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 show 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 wholly at the candidate's risk. *(File to be named "10.Pubblicazione 1"; etc).*
DOCUMENT CHECKLIST	**Required Documentation:** ➤ **CV** *(to be named "01.CV");*

➢ **Copy of a current identification document** *(to be named "02.Documento Riconoscimento")*;

➢ **Degree qualification certification for first (Bachelor's) degrees and second (specialization/Master's) degrees (or 5-year Single Cycle degrees)** *(to be named "03.Titoli di Laurea")*;

➢ **Abstract of the thesis topic for specialist/Master's degree (or five-year Single Cycle degree)** *(to be named "04.Abstract Tesi")*;

➢ **Candidate thesis for specialist/Master's degree (or five-year Single Cycle degree)** *(to be named "05.Tesi")*;

    PhD research proposal *(to be named "06.Proposta di Ricerca"*

<u>**Optional documentation:**</u>

➢ **Self-certification declaration for any other qualifications** *(to be named "07.Dichiarazione altri titoli")*;

➢ **Either one or two letters of reference from teaching staff** *(to be named "09.Lettera presentazione 1", "08. Lettera presentazione 2")*;

➢ **Language certification** *(to be named "09.Certificazione linguistica 1"; etc)*;

➢ **Any publications** *(to be named "10.Pubblicazione 1"; etc)*.

ADMISSION EXAMINATION	
1.ASSESSMENT OF QUALIFICATIONS HELD	Assessment of qualifications held (average exam scores, final degree mark, theses, Master's degrees, post-graduate courses, language certification, publications, etc.).
2. ASSESSMENT OF RESEARCH PROPOSAL	
3. INTERVIEW	The interview provides an opportunity for a complete evaluation of the candidate and a verification of the applicant's aptitude for research and willingness to undertake experience abroad, as well as areas of research interest. N.B.: *In the absence of certification from an accredited examination board showing a minimum B2-level knowledge of English, the candidate's language proficiency will be assessed during the interview.*
DATES OF INTERVIEWS	Tuesday 20 Sept 2022; Wednesday 21 Sept 2022.
The Examination Board will assess candidates' qualifications and interview with a mark **out of 100** (maximum mark for qualifications 20, research proposal 20 and interview 60).	

Candidates awarded less than **10 marks** for the **qualification evaluation** will not be admitted to the research proposal phase of the selection process.

The minimum pass mark for the **evaluation of the research proposal** is **10**.

The minimum pass mark for the **interview is 30.**

The minimum overall pass mark for the selection procedure is 50.

The results of the Board's assessment for qualifications and research proposals will be published on the Esse3 portal in the private area of each candidate. No other direct notification will be sent to the 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 Examination Board.

LIST OF RESEARCH TOPICS FOLLOWS

GRANT N. 1
DRISS

D.M. 351/2022
Area: Public Administration

Topic: "*Energy recovery systems and modelling for sustainable urban clusters and energy communities*"

RESEARCH PROPOSAL:

Urban areas are responsible for 70% of global primary energy-related CO_2 emissions associated to energy consumptions due to transport, housing, and commercial facilities, posing a significant strain on sustainable development. To this aim, European policies and programmes such as the *NextGenerationEU* promote the sustainable development of cities and communities, supporting the implementation of new solutions for urban energy systems and clusters. To address the related technical and socioeconomic challenges, the research community is thus called to develop innovative solutions for building clusters at energy level with the aim of integrating on- site renewable energy technologies, innovative energy storage systems, and advanced energy management logics.

As a response to this challenge, the project focuses on the development of an holistic modelling approach for designing resilient, flexible, and energy efficient urban districts. These are defined as building clusters able to optimally interact with energy grids, by exploiting local renewable generation systems, energy storage systems, and by adopting innovative energy management strategies based on sector coupling and demand response strategies in a smart energy system perspective. The aim of the project is to propose representative renewable building clusters and districts able to achieve energy resilience by generating and managing energy locally.

In this framework, the proposal seeks at developing a holistic and multi-scale research platform, based on the dynamic simulation and testing, for the design and optimization of sustainable building clusters and districts, integrating renewable technologies and emerging storage systems, and adopting optimal energy management scheme, with the multiple aims of:

•	Developing building clusters and districts models following a physics-based bottom-up approach to simulate the thermal and electric behaviour of building archetypes (calibrated on existing building stock datasets and simulation platforms), and to design and retrofit buildings' solutions for energy efficiency and flexibility.

•	Developing a whole dynamic simulation tool for the assessment and optimization of single and aggregated buildings' energy demand profiles, also as a function of human behavioural patterns, and of on-site renewable generation to evaluate self-generation capacity.

•	Creating novel energy management schemes for the mutual exchange of energy fluxes within and among buildings and energy users at cluster and district levels as well as towards the grid, by exploiting the use of energy storage systems and demand response strategies, to enhance energy autonomy and add flexibility.

•	Conducting the proof-of-concept of the best energy management scheme, to be implemented in an existing building cluster, also exploited for model validations purposes.

•	Providing guidelines for energy policy makers, system designers, and stakeholders to aid the design of sustainable building clusters and districts, the implementation of suitable energy management schemes, and the definition of correct grouping criteria.

The project will accelerate the development of sustainable and resilient districts to minimize carbon emissions and to achieve energy security while meeting the goals of sustainable development. In this regard,

the project aims at answering several key research questions, such as:

- Which criteria drive the *clustering* of buildings in blocks to be interconnected?
- Which and how energy efficiency measures and local renewable energy sources can be implemented at building and city level?
- Which is the level of detail achievable for coordinating the energy flows among multiple energy objects within a district?

- How emerging energy storage and demand response strategies may enhance the self-sufficiency of districts while also being able to offer flexibility services to the grid?

Although some of the above questions can be answered one at a time by means of available commercial software, the development of multi- domain and holistic simulation platforms useful to deal with these challenging questions is still an *open research topic*. Through the development of urban energy modelling tools for the dynamic simulation of multiple buildings and urban energy objects will be possible to pursue the goals of the project, which is to provide guidelines for the early design and retrofit of sustainable districts towards energy self- sufficiency. This project intends to deal with these issues by exploiting the expertise of the research consortium, while applying the new discoveries to case studies selected within Southern Italy.

The final Ph.D. product will be the development of a comprehensive yet flexible dynamic simulation tool for the design, optimization, and operation of energy self-sufficient districts, where multiple interconnected buildings interact with smart energy networks and local infrastructure, distributed renewable systems, energy storages and e-mobility as a smart energy system. The innovative simulation platform will be exploited, in case of new designs and retrofits, for the identification of **energy efficiency options**, to be defined as a result of optimization procedures also necessary for sizing purposes. Energy efficiency options will be investigated at multiple levels, including:

1. **buildings level**, such as: optimization of passive design and integration of active solar technologies, high performance artificial lighting, high-performance and optimally controlled HVAC systems, integrated renewable energy systems (e.g. solar thermal and PV, wind), energy storage systems (e.g. thermal, electrical).

2. **district level**, such as: implementation of district energy networks (e.g. district heating and cooling, smart grid), renewable energy supply from on-site generation (e.g. solar, wind, biomass), energy storage systems (e.g. thermal, electrical, hydrogen).

Moreover, the simulation platform will also be exploited for the implementation of **energy management schemes**, e.g. energy sharing, demand response to optimally manage the system so as to avoid issues of excess electricity production due to the unpredictable production of RES. In this regard, *Artificial Intelligence* (AI) and *Machine Learning* (ML) techniques will be explored to develop innovative control strategies and energy management strategies which can substitute to the user in the process of optimizing the energy mix. The resulting tool, by handling complex interactions between different energy entities, will be able to achieve optimal district energy performance for sustainability and resilience, and to test and derive innovative *energy business model* applied to energy initiatives and sharing schemes; attention will be paid to the Italian context and regulatory framework.

The platform will be developed in partnership with ENEA and will enable the simulation and optimization of *case studies* to be considered as benchmarks for obtaining **novel technological pathways and policy inputs** to be applied in sustainable districts. The *case studies* will be designed starting with representative clusters or districts, made up by exploiting 3D GIS-based integrated design tools. Such clusters will include the buildings, the local generation systems, the energy storages, e-mobility, as well as the energy networks. It can be anticipated that the towns of Accadia and Biccari (Foggia, Italy), will be considered as a real *case studies* for which collected energy consumption data

are available and it will be used the implementation of innovative *energy efficiency options and energy*

management schemes for the sustainable transition of the village. These towns have been selected within the PNRR competition "Turismo e Cultura - Attrattività dei Borghi", and as such, will be ideal manageable case studies to test the results of the project.

From a larger perspective, this project aims at providing design criteria and guidelines for the implementation of energy management schemes in existing and replicable districts for the sustainable energy transition. Therefore, it will support current EU and extra-EU policies about climate neutrality in cities, as driven by the 2nd recast of the Energy Performance of Buildings Directive and the European Environmental Action Programme (EU-EAP), and with the related Horizon 2020 and Horizon Europe targets towards the sustainable urban development and the energy transition. In particular, two research lines that will be investigated include:

−   **Design and implementation of advanced community-scale storages for flexibility aims**; advanced energy storage systems (electric, thermal, as well as hydrogen) will be implemented to provide flexibility to the cluster of buildings. Batteries (e.g. lithium-ion) and thermal (e.g. sensible and latent) storages will be considered for storing electricity and heat to add flexibility to the buildings. Surplus of electricity from renewables will be exploited to i) charge stationary batteries located at building level; ii) supply electric vehicle batteries for motion uses and for vehicle-to-home (V2H), and vehicle-to-buildings (V2B[2]) aims; iii) supply heat pumps for charging thermal storages. The WP also aims at developing novel paradigms to perform flexible and interactive energy management within the district to enhance the share of energy among buildings and users towards flexibility and energy self-sufficiency.

−   **Development of a novel whole dynamic simulation and optimization tool;** despite the growth in physics-based modelling tools (e.g. CityBES, UMI, UrbanOPT, TEASER, CityGML) noticed in the last years, there is a lack of tools that can link building energy performance simulation (BEPS) tools for co-simulations and geographic information system (GIS) databases of multi energy sources. Simulation model of buildings and energy storage systems / components will be suitably integrated in a novel whole dynamic simulation (developed in MatLab/Simulink, Python, TRNSYS), based on a matrix approach for the simulation of thermal and electric networks. The tool will be also integrated with optimization algorithms; criterion and parameters will be identified for performing multi-objective optimizations of the proposed scenarios.

GRANT N. 2

DRISS

D.M. 352/2022
Co-funded by: CAV s.r.l.

Topic: "*Development of new pre-mixes for eco-sustainable construction obtained from re-use of waste plastics*"

RESEARCH PROPOSAL:

In recent decades, the need has emerged in the construction industry to take immediate actions to reduce environmental impact and develop innovative technologies in the field of eco-sustainable materials production. First and foremost, the research project is aimed at the local area and companies in the construction industry active in the field of building and recycling of waste materials. The development of new premixed products for making slabs with innovative and eco-sustainable character, using PET fibers from recycling, simultaneously offers, building innovation and environmental sustainability with the possibility of minimizing the impacts of the building process on the environmental, social and economic environment, as well as offering concrete conceptual and operational tools to expand and increase the field of these new materials

In light of the foregoing, we intend to conduct a study aimed at the reuse of waste plastics, in particular polyethylene terephthalate (PET), for the production of materials in the building field, such as premixed slabs. The scenario of the recycling of waste materials and the reuse of construction debris fits in coherently with the National Smart Specialization Strategy 2014-2020 (SNSI) for the development of innovative systems and for the production and distribution of sustainable energy and low-content of CO_2, involving sectors of interest such as residential and production. The design idea offers a starting point for the optimization of the production process of the conglomerate material, paying particular attention to developing and perfecting systems and technologies aimed at *waste treatment*.

The scientific-experimental activity involves the development of the composition of the material (concrete mix) by an optimization study of the percentage of PET fibers and the realization of several experimental campaigns on premixed samples reinforced with recycled fibers subjected to compression tests, bending tests and impact tests. In particular, the research will develop in different phases:

1. Low-cost design and manufacture of PET elements.
2. Optimization of the composite in terms of the percentage of PET fibers and cementitious matrix.
3. Production of samples to be used as control tests and production of samples with recycled materials.
4. Experimental campaign on specimens subjected to static tests to determine the mechanical properties.
5. Thermal-acoustic conductivity tests in order to evaluate the potential of the new material for insulation applications.
6. Analysis of the results and definition of the optimal mixture.

The research proposal involves collaboration with a company that produces building materials. The collaboration with the business partner will allow the Ph.D. student to carry out a research experience within an intersectoral context, by mean of experimentation too. This collaboration will allow future forms of employment of the Ph.D. researcher as a specialized figure. The innovative materials developed will have the requisite of sustainability in reference to the new social, economic-productive and construction industry needs. Furthermore, possible synergies could be activated with the associations that bring together the companies involved in the recycling of post-consumer plastic materials.

GRANT N. 3

DRISS

D.M. 352/2022
Co-funded by: I-AM s.r.l.
Topic: "*Methods and tools for the management of complex infrastructures*"

RESEARCH PROPOSAL:

The proposal refers to the thematic area Digital Agenda, Smart Communities, Intelligent Mobility Systems of the SNSI, recalling the technological development trajectories of national priority Systems for the safety of the urban environment, environmental monitoring and prevention of critical or risky and 'embedded' electronic systems, networks of intelligent sensors, internet of things.

The proposed research activity aims at defining techno-organisational models for the creation of an Integrated Data Environment between the digital E&C domains and BIM (Building Information Modeling) with the digital O&M domains and the EAM (Enterprise Asset Management) / APM (Asset Performance Management) methodologies and platforms - in response to the management needs of complex infrastructures. The proposed research path therefore aims at analysing the theme of the integration of digital E&C and O&M in the context of complex infrastructures defining solutions and processes that respond in an innovative way to the needs of the market, anticipating them.

The proposed activity is highly innovative and current, there are several existing studies and research activities that are moving in this area, but the state of the art lacks solutions that provide an integration between BIM, EAM and APM that is effective and efficient for the complex infrastructures.

The issue of defining tools and methodologies for the management of complex infrastructure is perfectly aligned with the aims and areas pursued by the College of Professors.

In detail, the research activities planned to ensure the technical feasibility of the project will concern:

- A1. Analysis of the state of the art in the scientific literature
- A2. Study and analysis of international reference standards in the field of BIM, Asset Management and data exchange.
- A3. Analysis of methodologies and technological platforms.
- A4. Assessment of criticalities and information needs in the management of complex infrastructures.
- A5. Definition and validation, through relevant case studies, of techno-organisational models (e.g. methodological frameworks, processes, data models) aimed at integrating the two domains under analysis.

The doctoral student will acquire specialised and technical skills that will enable him/her to enter the labour market with a solid background and up-to-date state-of-the-art knowledge. He/she will be able to find employment in specialised companies in the field of construction and monitoring of complex infrastructures, in organisational and technical consultancy companies related to asset management, or undertake further research paths.