



IMT SCHOOL PHD PROGRAM IN "MANAGEMENT OF DIGITAL TRANSFORMATION",

**CALL FOR APPLICATIONS 2023/2024
EXECUTIVE SUMMARY**

PHD PROGRAM DESCRIPTION

The IMT School for Advanced Studies Lucca has launched the call for applications for the PhD Programs in "Management of Digital Transformation" (2023/2024 academic year):

<p>Course Description</p>	<p>The digital transition implies profound and highly complex technological, organizational, managerial, and economic changes in all sectors of society, with an important impact on green revolution and environmental sustainability. The ability to govern such changes is essential to take advantage of the opportunities made available by digital innovation by dominating the potential associated risks. The entrepreneurial system, in particular the small and medium-sized enterprises that constitute the beating heart of the Italian economic fabric, may not be ready to grasp the challenges posed by the digital transition as they do not have distinctive multi- and interdisciplinary skills capable of combining set strategic directions with the innovations deriving from the application of digital technologies. Digital transformation also necessarily addresses the psychological and cultural elements of change. Therefore, a correct socio-cultural, behavioral, and psychological approach is necessary to foster change.</p> <p>The objective of the PhD course in "Management of Digital Transformation" is to train a new executive class to respond to the management needs of digital transition processes, drawing inspiration from and responding to the needs outlined in the PNRR to bring businesses and institutions together with universities and research.</p> <p>The MDT doctoral program pursues this goal by combining a "horizontal" approach to academic activities with a "vertical" approach to research. The PhD Program offers a cross-disciplinary educational offer of a multidisciplinary nature dedicated to digital transition issues addressed from a cultural, economic, social, engineering, IT, legal, managerial, neuroscientific, and psychological perspective. Research activities envision a specific in-depth study on a highly-qualified scientific project aligned with the student's curricular profile and motivations.</p> <p>In this context, a distinguishing feature of the PhD Program is the presence of companies and institutions: in fact, a preponderant share of scholarships is expected to be co-financed by - and each scholarship linked to - a research project developed jointly by an academic advisor, to ensure scientific quality, and by a company/institution representative, to ensure the impact, even in the long term, of the research object.</p>
<p>Output Profiles</p>	<p>In the study on "The Future of the Jobs" presented at the World Economic Forum 2016, it emerged that, in the coming years, technological and demographic factors would profoundly influence the evolution of the labor market. With the advent of enabling technologies for Enterprise 4.0, the skills and abilities sought will change. To date, companies and public institutions are encountering increasing difficulties in</p>



	<p>identifying, both at the level of graduates and graduates, the skills necessary for the digital transition. Universities cannot adequately train people and guarantee an effective and rapid placement into the job market around these innovative issues. Thus, this PhD Program aims to provide highly sought-after digital skills for the new tasks of the future, that is, that extensive set of technological skills that make it possible to identify, evaluate, use, share, and create content thanks to information technology. The PhD Program will also provide in-depth transversal skills both in research and innovation on enabling technologies for Industry 4.0, with particular regard on their exploitation for the green revolution and the environmental sustainability, and for corporate lean and personnel management to be in line with the features of intelligent work, i.e., work that integrates manual interventions with solid technical skills of analysis, diagnosis, and scientific reasoning, and the application of complex knowledge.</p> <p>Career opportunities comprise the academic field in different scientific disciplinary sectors, including engineering, information technology, and economics, as well as technical-scientific and managerial roles in public and private companies and institutions. The partnership with leading companies and institutions in their respective sectors to develop research projects of high industrial and applied interest will provide an additional advantage to students in terms of employment opportunities.</p>
--	---

The IMT School adopts equal opportunity principles in its selection procedures and rejects any type of discrimination based on sex, gender identity, nationality, ethnicity, religious belief, sexual orientation, state of health, and any other status or quality that is not strictly relevant to the call outlined in this document.

Program official duration: 3 years.

Programs start on November 2nd, 2023.

PhD Program Coordinator: Prof. Marco Paggi

Program official language: English.

Scholarships: 4 (distributed among research projects as follows)

Titolo progetto	Impresa
<i>Precision medicine</i>	ROCHE
<i>Territorial-based management of patients with cancer</i>	Toscana Life Sciences
<i>Knowledge Network Analysis</i>	ENI S.p.A.
<i>Development of new technologies for the hydrogen supply chain: simulation methods aimed at the industrialization of devices for the production, storage and use of hydrogen</i>	Ne.m.e.sys S.R.L.

The number of positions may be increased in the event that additional funding is made available after the publication of the Call.

Scholarship gross amount: 16,243.00 Euros/year (see the "Scholarships" paragraph).

Additional benefits:

- All PhD students admitted to the PhD Program are exempt from paying tuition fees, although they are still responsible for paying the yearly Regional Education Tax (currently 140.00 Euros/year);
- All PhD students are offered free meals (lunch and dinner) at the on-campus canteen;
- All PhD students are provided with free accommodation in shared double rooms within the campus residential facilities.

REQUIREMENTS

Applications are open to candidates who meet the following requirements:

1. **Degree:**

- "Laurea Magistrale" or "Specialistica" (according to DM no. 509, of November 3, 1999), or a four- or five-year degree (according to the previous rules of the Italian higher education system) obtained in Italy;
- Foreign degrees that give access to the PhD in the Country where it has been awarded.

For the selection procedure, candidates are required to upload the documents indicated in Table 2 - Attachments to the application.

Applicants who obtain their degree by no later than **October 31st, 2023**, can also apply. These candidates will be admitted to the selection procedure "with reserve" and must provide their degree certificate by the date of enrollment, or they will be excluded from the program.

2. **Knowledge of the English language:** Applicants are required to indicate their level of English.

APPLICATION

The **application form** must be **mandatorily** filled out in **English** through the School's online procedure **by September 11th, 2023, at 1:00 pm (CEST)**.

Applicants must upload the **documents** in **PDF**. The **maximum size is 30MB** for each attachment.

The Selection Committee will accept **attachments** in **Italian or English only** (unless otherwise specified in the table below).



Table 1: Information		
Personal information	compulsory	In this section, applicants must enter their personal data (name, address, contact details, etc.).
English Language Level	compulsory	Applicants must indicate their level of English.
Additional information/Interview	compulsory	Applicants have to indicate the modality for the interview (IMT School campus, videoconference, or similar, or by telephone at an Italian embassy/consulate).
Additional information/Disability	optional	Applicants should indicate if they need assistance to participate in the selection procedure.
Additional information/How did you first find out about IMT?	compulsory	Applicants are required to indicate how they found out about the IMT School.
Education	compulsory	Applicants are required to indicate their university degrees (whose duration must be equivalent to at least 4 years of university studies), the average exam mark, and final grade (if any) for each degree obtained.
Additional qualifications	optional	In this section, applicants may list any other qualifications considered relevant in relation to their application.
Publications	optional	Applicants can list their own published articles, books, or any material that may be considered relevant for the PhD and research activity.

Table 2: Attachments		
1	Copy of National Identity Card or Passport	<p>compulsory</p> <p>Applicants have to upload a copy of a valid identity document:</p> <ul style="list-style-type: none"> • <u>For Italian and EU citizens</u>: Valid National Identity card or Passport • <u>Non-EU applicants</u>: National Identity card or Passport (the latter is highly recommended). <p>The copy has to be signed by the candidate, indicating the date and place of the signature. In particular, the document has to contain the applicant's photograph, personal data, and document number, place and date of issue. If any of the above information is missing, the document will not be accepted.</p>



			<p>If the document is not in English or Italian, a translation into English or Italian should also be uploaded (an official/legal translation is <u>not</u> required).</p> <p>In the event that the copy of the document is unreadable, the Selection Committee may request a new submission.</p>
2	Curriculum vitae et studiorum/Resume	compulsory	<p>Applicants must upload their curriculum vitae et studiorum/resume in Italian or English (the latter is highly recommended), indicating their university degrees, work and research experience, and publications (if any).</p>
3	Education	compulsory	<p>Candidates are required to upload one of the following documents in Italian or English:</p> <ul style="list-style-type: none"> • for degrees obtained in Italy and/or in France, Ireland, Belgium, Denmark (Bruxelles Convention of May 25, 1987), and Germany (Italian-German Convention, ratified by the Law no. 176 of 1973): a self-declaration stating the possession of a degree, conferral date, issuing University, and final grade; • for degrees obtained in all other EU and non-EU countries: an official certificate indicating the possession of a degree, conferral date, issuing University, and final grade.
4	Academic transcript/Diploma supplement	compulsory	<p>For each degree, the applicant has to attach one of the documents listed below in Italian or English (English is highly recommended):</p> <ul style="list-style-type: none"> • Academic transcript: an official document detailing the course, classes attended or subjects studied and results, completion date, graduation date; <p><u>or alternatively,</u></p> <ul style="list-style-type: none"> • Diploma Supplement: document produced by the University accompanying the diploma, providing a standardized description of the nature, level, context, content, and status of the studies completed by the applicant (https://ec.europa.eu/education/diploma-supplement_en).
5	Research Project	compulsory	<p>Candidates are required to express their preference for up to three (3) research projects as referred to in Article 1 of this call for applications.</p> <p>The preference expressed by candidates will not be binding when assigning the projects (see "Final Ranking").</p>
6	Research Statement	compulsory	<p>To best evaluate each candidate's aptitude for the PhD Program, all candidates must upload a document (maximum 10,000 characters, spaces included) mandatorily in English, describing:</p>



			<ul style="list-style-type: none"> - the candidate’s competencies and experiences within the scientific or academic field relevant to the project(s) chosen and how they would use them to address the project(s); - the candidate’s motivation for pursuing study at the IMT School, with particular reference to the project(s) chosen; - future projects.
--	--	--	---

If the application lacks a piece of information or an attachment referred to as "compulsory", applicants can be conditionally admitted to the selection procedure. Their application will be considered valid only if they produce the required documents by the day scheduled for the interview.

The correct completion of the online application procedure is **confirmed by an automatic email** sent to the email address indicated by each applicant while registering for the procedure; the message only confirms the receipt of the application. The School will not verify the validity and completeness of applications before the call closes.

After the submission, no changes are allowed to the entered data.

Candidates are also required to fill out a **separate section of the application form** dedicated to referees:

References	compulsory	<p>Applicants are required to provide the names and contact information of two referees.</p> <p>The referees who are invited to submit a reference letter in English through the IMT School’s online application system, - by October 3rd, 2022, at 12:00 pm (CEST), will receive an automatic notification from the School’s application system.</p> <p>Applicants will receive an automatic notification when a letter is submitted, but they may not access any reference provided.</p>
-------------------	------------	--

SELECTION COMMITTEES

The Selection Committee is nominated by decree by the Rector of the IMT School in accordance with the School regulations and comprises experts from relevant fields.

EVALUATION CRITERIA AND SELECTION PROCEDURE

Evaluation criteria

The Selection Committees will evaluate candidates’

- academic background, knowledge, skills, and scientific potential;
- general aptitude for research and potential to collaborate in the specific research activities of the selected Track in the application form;
- interdisciplinarity, knowledge, and skills with reference to the multidisciplinary of the IMT School PhD Programs;
- pertinence to a track different than the one selected in the application form.

Assessment of qualifications

The first phase of the selection procedure is the assessment of qualifications. This assessment is carried out in relation to the specifics of the PhD Programs and specifically to determine who is admitted to the interview.

In the assessment of qualifications phase, the evaluation of the candidates is carried out by the Committees defined in the previous paragraph "Selection Committees" and based on the candidates' application form, uploaded documents, and reference letters provided by referees.

Based on the assessment of qualifications, the Selection Committees will draw up a shortlist of candidates admitted to the interview in alphabetical order.

The shortlist of applicants admitted to the interview will be published on the School's website and Online Notice Board ("*Albo Online*").

This is the only official communication of the preliminary results to all applicants.

Interview

Candidates admitted to the **interview** – that will take place on **September 25th, 2023** – must confirm their participation by email to phdapplications@imtlucca.it within two (2) days of the publication of the shortlist, confirming their preference to have the interview conducted in one of the methods indicated in the "Application" paragraph of this call.

During the comprehensive interview, the Selection Committees will assess the candidates' knowledge and skills with reference to the specific characteristics of the PhD Program.

The Selection Committees will assess all interviews by assigning a score (up to 100 points): applicants scoring at least 70 out of 100 will be eligible for the Program and, therefore, listed in the final ranking.

Final ranking

At the end of the interviews, the Selection Committee will draft the final ranking of the eligible candidates for each research project according to the scores obtained in the interview. The preference expressed by candidates in the application form is not binding: the Committee can thus assign candidates to the ranking of projects deemed most corresponding to their profile.

In the event that additional subject-restricted positions become available after the opening of the present call for applications, the Selection Committee reserve to assign eligible candidates to the relevant rankings.

If multiple candidates get the same score, preference will be given to the youngest candidate.

In the event of the withdrawal or exclusion of a candidate, they shall be replaced by the next suitable candidate according to the ranking.

All rankings will be published on the School's website and Online Notice Board ("*Albo Online*").

ENROLLMENT

Once admitted to the PhD Program, candidates wishing to enroll must submit the complete enrollment form to the IMT School **no later than five (5) days from the publication of the results** on the School's Online Notice Board ("*Albo Online*") and website, using one of the following methods:

- in person or by post to:

IMT School for Advanced Studies Lucca
PhD and Higher Education Office
Piazza S. Ponziano, 6
55100 Lucca – Italy

- by certified email to imtlucca@postecert.it

Failure to submit the enrollment request by the deadline and through the above-mentioned methods will result in an automatic withdrawal of the candidate from the Program.

The enrollment request is valid only if all the requested documents have been enclosed.

If any of the documents submitted during the application procedure do not correspond to those submitted during enrollment due to an intentional false declaration, the applicant will automatically lose their right to enroll in the program.

Enrollment is effective on the first day of official classes. Unauthorized absences may nullify the enrollment procedure.

SCHOLARSHIPS

The scholarship amount is 16,243.00 Euros/year and shall be disbursed in monthly installments.

For any research or training activities at universities or research centers abroad, the scholarship amount is increased by 50% for the first nine (12) months.

Scholarships are subject to the payment of social security contributions (INPS) managed separately under Article 2, paragraph 26 of Law no. 335 of August 8, 1995, as amended, with two-thirds paid by the Administration and one-third by the scholarship recipient.

Admitted candidates who have already benefited from a PhD scholarship in Italy cannot be assigned another one.

The scholarship has a maximum duration of three (3) years and is subject to annual confirmation: according to articles 15 and 16 of the IMT School PhD Regulations, students must complete all the activities provided for each academic year.

If a student withdraws or is excluded within 45 days from the beginning of the Program, they are not entitled to the scholarship. The scholarship will be awarded to the next eligible candidate according to the final ranking. For this reason, the first scholarship payment will be made only after the successful completion of the first 45 days of the program.

If a student registers after 45 days from the beginning of the Program, he/she is entitled to the scholarship starting from the actual date of enrollment.

FACILITIES

Residential facilities: accommodation

All PhD students who are granted a scholarship have free accommodation in shared double rooms with private bathrooms, priority being given to on-campus residential facilities, or are assigned a housing grant for the entire official duration of the Program (3 years), except for periods spent off campus for study and/or research.

The School can revoke the right to accommodation if it is rarely or not used.

Residential facilities: canteen

All PhD students are offered free meals (lunch and dinner) at the School canteen located on campus for the entire official duration of the Program (3 years). Lunch and dinner are served each day, Monday through Sunday, for the entire academic year, except for the closing periods.

Other facilities

All PhD students have access to library facilities and can benefit from the IT support services for all technical requests related to study and research until the thesis defense.

The School subscribes to an insurance policy for all PhD students. It provides coverage against accidents and injuries incurred by students in Lucca or abroad while performing academic activities. The IMT School also provides students with health insurance policies for research trips outside Europe (students are automatically covered in European countries).

All international PhD students are offered the possibility to take an Italian language and culture course.

TREATMENT OF PERSONAL DATA

The IMT School will use the personal data provided by applicants solely for selection procedures and institutional aims in accordance with the provisions of the current European and Italian legislation (EU Regulation 2016/679 and Italian D. Lgs. 196/03 - *Italian Privacy Code*, as modified by the D. Lgs. 101/2018) and the relevant School Regulations.

Applicants are granted all the rights established by art. 15, sections 2, 3, and 4 of Chapter III, and art. 77 of the EU Regulation 2016/679.

For further information regarding the call and the selection procedure, please contact the PhD and Higher Education Office by email at phdapplications@imtlucca.it or by phone at +39 0583 4326530.

Further information regarding the PhD Programs and the IMT School is available at www.imtlucca.it.

FINAL PROVISIONS

Relevant laws and the IMT School PhD Regulations shall be applied to any issue or item not covered by the present call for applications.

**PHD IN "MANAGEMENT OF DIGITAL TRANSFORMATION"
RESEARCH PROJECTS**

Precision medicine

Regarding the research project, the PhD students will focus on the topic of implementing personalized medicine (PM) solutions in the clinical setting.

In terms of training, PhD students will participate in specialized advanced courses offered by the PhD program of the IMT School for Advanced Studies Lucca on topics such as enabling technologies for Industry 4.0, health economic models to assess the cost-benefit ratio of innovative health interventions, the management of innovative health technologies, and digital transition processes and their impact on improving health services.

If necessary, this training activity can be enriched by additional external courses or by seasonal schools on specific topics aimed at developing research work. In addition to courses of a scientific and technical nature, the student will develop soft skills through seminars offered by the IMT School for Advanced Studies Lucca on the fundamentals of academic entrepreneurship, intellectual property management, communication techniques for the dissemination and valorization of research, and critical thinking. The skills acquired aim at developing the research project and training a researcher for his future job placement both in the academic field and in technical-scientific and managerial positions in public and private companies.

Regarding the research project, the PhD student will focus on the implementation of personalized medicine in healthcare and clinical settings, with a particular emphasis on the health economic implications of personalized medicine.

As the potential benefits of genomics and PM began to unfold, the concept of Predictive, Preventive and Personalized Medicine (PPPM or 3P Medicine) represents a new era in 21st century medicine: Precision medicine interventions are demonstrating their health benefits to people's and patients' lives while becoming more affordable to be reimbursed by health systems. Nevertheless, the introduction of precision medicine in the clinical setting requires innovative organizational solutions and the development of appropriate HTA and health economic modelling approaches.

This PhD position aims to develop an interdisciplinary approach to accurate economic and social evaluation of precision medicine interventions (i.e., drugs, diagnostics including companion diagnostics).

For precision medicine to flourish as an emerging industry and for health systems to modernize, public and private investments must be thoughtfully and strategically planned, while public policy must create an enabling environment.

The following three points are essential first steps to keep Italy and the EU as a whole at the forefront of healthcare:

- Quantitative and qualitative analysis is needed to determine what policies need to be implemented at the regional and national levels, what data infrastructure needs to be developed and implemented, and what personnel need to be properly trained to bring PM to bear and ensure that data can be shared securely and anonymously both nationally and internationally. Looking to England and Australia as models for implementing national genomics strategies may help.
- Health economics approaches to evaluating precision medicine and architectural innovation in health care. New solutions based on health analytics and real-world evidence will be developed.
- An interdisciplinary approach must be implemented to evaluate the ethical, social, regulatory, and sustainability requirements of personalized medicine.

Research outputs include publications on health economic models for precision medicine, appropriate reimbursement systems based on cost-benefit analysis, and new organizational and analytical solutions for precision medicine.

This scholarship includes a mandatory internship at ROCHE (from a minimum of 6 months to a maximum of 18 months, depending on the research plan), and a visiting period in a research center abroad (from a minimum of 6 months to a maximum of 12 months).

Territorial-based management of patients with cancer

Regarding the research project, the Ph.D. student will concentrate their activities on the theme of new governance models for the territorial-based management of cancer patients.

From a training point of view, the Ph.D. student will attend specialized advanced courses provided by the Ph.D. program of the IMT School for Advanced Studies Lucca on topics concerning enabling technologies for healthcare 4.0, the management of innovative and digital technologies for health as well as digital transition processes and their effect on the improvement of healthcare services.

Where necessary, this training activity can be enriched by additional external courses or by seasonal schools on specialistic topics aimed at developing the research thesis. In addition to the courses of a scientific-technological nature, the student will develop soft skills through seminars offered by the IMT School for Advanced Studies Lucca on the foundations of academic entrepreneurship, the management of intellectual property, communication techniques for dissemination and valorization of research, and critical thinking. The skills acquired will be aimed at developing the research project and training a researcher for his future job placement both in academia and in technical-scientific and managerial roles in public and private companies.

Regarding the research project, the Ph.D. student will concentrate their activities on the transformation of healthcare governance for better managing cancer patients in all phases: primary prevention, treatment, follow-up, and secondary prevention. This research program will tackle the main challenges of health and care in Europe, which is being radically transformed along four main drivers:

- Improve the health outcomes towards more predictive, preventive, personalized, and participative health;
- Combination of traditional therapies, immunologic, nutrigenomics, and genomics with digital therapies that can be delivered in settings other than Hospitals;
- Capacity to gather and process huge datasets to better plan healthcare interventions;
- The disruption of new technologies such as Artificial Intelligence, the Internet of Medical Things, augmented reality, and process automatization for better management of cancer patients;

There are 3.6 million cancer patients in Italy, with 1000 new diagnoses every day. These patients are mainly treated in traditional healthcare facilities. The management of cancer patients accounts for 20 Billion €/year to the public healthcare system. To date, as the uptake of digital solutions for health services remains slow and varies significantly across Member States and regions, further action is crucial to accelerate the meaningful use of digital solutions in public health and healthcare to improve the management of cancer patients.

With regard to the research project, the Ph.D. student will focus on the study of:

1. Interoperable GDPR-compliant and cross-regional healthcare models able to fully exploit health data using innovative digital approaches (AI, big data analytics, machine learning, etc.);
2. Data standardization/interoperability models for collection and use of data for public health purposes; Standards for data quality for research purposes (i.e., HTA, PoC);
3. Accessibility, cyber security, privacy & data protection standards;
4. Governance and procurement models for implementing territorial-based management of cancer patients.

Knowledge Network Analysis

Knowledge Network Analyses (KNAs) are activities for collecting, analyzing, and interpreting data related to collaborative networks between people.

At Eni, KNAs have been conducted for about 10 years to study how these networks evolve over time due to organizational changes and the evolution of the company's business units.

The research activity of the PhD student, which takes place within the Doctoral Program in Management of Digital Transformation, consists of:

- developing effective surveys and data collection strategies on inter-organizational collaboration networks;
- analyzing and interpreting the knowledge network data to identify key findings to support innovation;
- examining the temporal evolution of the network by comparing the results of similar KNAs repeated over time;
- proposing new techniques and solutions to measure and incentivize collaboration in specific areas.

The above-mentioned research activity is developed within the framework of the project "Economic and Digital Resilience" (RED), thanks to which the IMT School has been selected among the Departments of Excellence 2023-2027 and has received funding of more than 5 million euros from the Italian Ministry of University and Research.

The RED project aims at analyzing the available evidence on economic and digital resilience in an interdisciplinary way in order to develop innovative digital solutions for the new way of working after the pandemic. At the heart of the project is the creation of a virtual lab, called Open Lab, which will allow online, field and remote experiments to be carried out and, in parallel, will make a crucial contribution to doctoral training based on the learning-by-doing model.

This scholarship includes a mandatory internship at Eni (from a minimum of 6 months to a maximum of 18 months, depending on the research plan), and a visiting period in a research center abroad (from a minimum of 6 months to a maximum of 12 months).

Development of new technologies for the hydrogen supply chain: simulation methods aimed at the industrialization of devices for the production, storage and use of hydrogen

From a training point of view, the PhD student will attend specialized advanced courses provided by the PhD programme of the IMT School for Advanced Studies Lucca on topics concerning enabling technologies for Industry 4.0, the management of digital transition processes and their effect on ecological transition and environmental impact. Where necessary, this training activity can be enriched by additional external courses or by seasonal schools on specialistic topics aimed at developing the research thesis. In addition to the courses of a scientific-technological nature, the student will develop soft skills through seminars offered by the IMT School for Advanced Studies Lucca on the foundations of academic entrepreneurship, on the management of intellectual property, on communication techniques for dissemination and valorization of research and on critical thinking. The skills acquired will be aimed at developing the research project and training a researcher for his future job placement both in academia and in technical-scientific and managerial roles in public and private companies.

With regard to the research project, the PhD student will focus their activities on the mechanics of materials for the hydrogen supply chain, in cooperation with the company Ne.m.e.sys srl, a research company specialized in development of technologies for the hydrogen supply chain, 30% owned by Nuovo Pignone Holding spa of the international Baker Hughes group. Baker Hughes with Ne.m.e.sys is committed to fostering the energy transition and guaranteeing continuity for society's energy needs, targeting the world goals by 2050.

Manufacturing technologies are developing innovative fuel cells to produce low-cost hydrogen. For example, the United States Office of Energy Efficiency & Renewable Energy has set the goal of 2 \$/kg by 2025 and 1 \$/kg by 2030, through a path to net zero carbon emissions. In Italy, the cost of producing hydrogen at industrial sites is around 6 Euro/kg and the price of hydrogen in a pumping station is around 13 Euro/kg. New materials and technologies used for fuel cell membranes are expected to have a positive impact on reducing manufacturing costs. Likewise, their use in combination with intermittent sources can lead to more efficient distribution networks, significantly reducing delivery costs.

This PhD position aims to develop an interdisciplinary approach for an accurate assessment of the operational characteristics of hydrogen fuel cell technologies and storage systems, integrating materials research when considering realistic usage operations and accurate assessment of the life cycle (LCA). Research on computational mechanics will be exploited to develop models for the evaluation of the durability of components (membranes, porous materials, etc.) used in standard and innovative fuel cells, towards a more accurate evaluation of their duration and costs. Knowledge of electrical networks and intermittent renewable sources (eg wind and photovoltaic) will be used to evaluate the operational performance in the reduction of disturbances on the energy distribution network. The result of the technical information will be integrated with a refined LCA approach, in order to support informed decisions of policies and decision makers on key topics ranging from the operation to the end of life of fuel cells.

The research product will concern publications on the proposed methods for the mechanical characterization of materials and devices for the production of hydrogen. These results can be achieved both with traditional methods of an experimental nature, and through innovative methods of numerical simulation conducted with virtual testing techniques. The latter represent one of the main enabling technologies for Industry 4.0 aimed at reducing the time associated with laboratory experimentation and the development of new products and materials.

This scholarship includes a mandatory internship at Ne.m.e.sys (from a minimum of 6 months to a maximum of 18 months, depending on the research plan), and a visiting period in a research center abroad (from a minimum of 6 months to a maximum of 12 months).