Spain, and the European Union, has an energy dependency problem that is periodically the source of fierce debate about degrees of efficiency of energy conservation and the pros and cons of different power sources. The debate on energy becomes more intense in times of crisis or when political conflicts affect the supply and price of the energy we consume. Three fourths of the energy consumed in Spain is imported. Practically all of the oil and gas consumed comes from foreign countries, as well as an important amount of the coal used. Nuclear energy does have the potential to reduce our dependency on natural gas and lower the cost of electricity that is currently priced quite highly. 20% of the electricity consumed in Spain is produced by nuclear power generation and in Catalonia it is 45%.

Nuclear power meets the three requirements that any energy policy must satisfy. Security of supply, the raw materials come from politically stable countries, mostly in the OECD area. It is respectful to the environment by not emitting CO2 to the atmosphere, thus making it essential in the strategy to fight climate change caused by global warming. It offers a stable kWh cost which is resistant to the volatility of raw material prices. Furthermore, nuclear energy has another strategic competitive advantage which is the amount of energy accumulated in the small volume required by uranium when compared to natural gas, which is much more difficult to store and requires large-scale infrastructures both in the liquefied gas docks and in underground storage. Nuclear energy has always been a controversial subject and the source of intense social debate, often slanted by misinformation about its uses and risks. Memories of the accidents at Three Mile Island, and especially Chernobyl are ever present in discussions on nuclear energy. However, the lessons learned from these incidents have resulted both in technological advances and improved plant management, as undoubtedly will be seen in the recent Fukushima accident.

Despite all of these incidents, nuclear energy is safe, reliable and necessary. The age of the almost one hundred and fifty nuclear power plants in Europe and the peremptory need for an energy supply with which we are faced nowadays only leave us with two economically viable options; to extend the life of existing nuclear power plants or to build new ones. In a very short period of time this sector will therefore need professionals who are specialized in this area so that the workforces at these nuclear centres can be renewed. This course aims to train people to be able to quickly move into managerial positions in different organizations, whether they are companies within the nuclear sector or within the energy field. The participants on this Master’s course will learn the competences needed to manage projects that are run within a company; material supply logistics, plant safety and technical management. This course is structured into different subject areas that are linked transversally and go from theoretical fundamentals, calculations and technologies involved, to a general view of the nuclear sector which includes specific analysis of technical management of a nuclear power plant and the supply logistics process. In addition, students will do internships in companies and thus will be able to work with experts in the field who can offer them both their knowledge and experience.

The nuclear industry is highly internationalized, with companies from different countries involved in the same project. Therefore, this Master’s course will be taught entirely in English with a dual aim; so that it can be taken by foreign students and so that Spanish students are fully prepared to participate in projects abroad.

This pioneering Master’s course in Catalonia is strictly focused on nuclear power and is the result of various synergies and the coming together of many different parties including the School of Industrial Engineering of Barcelona, the Department of Physics and Nuclear Engineering, the Institute of Energy Technologies at the UPC and, in particular, ENDESA, which has provided their experience and full support for the internationalization of this Master’s course. If we also add the close collaboration between the Nuclear Safety Council and the UPC in terms of nuclear safety, we can conclude that this Master’s course provides all of the essentials needed to fulfil the expectations that exist within the sector and society alike and will fully satisfy the expectations of students.
INTRODUCTION

Worldwide demand for electricity is quickly growing. According to the International Energy Agency (IEA, World Energy Outlook 2010) the demand for electricity will increase, on average, by 2.2% annually until 2035. In a scenario of energy policies aimed at increasing energy security and reducing CO2 emissions, a significant part of the new power generation capacity installed worldwide will correspond to renewable energy technologies and nuclear power plants.

There are no plans to build new plants in Spain in the short term, but they will be necessary in the mid-term, and it must be taken into account that it takes several years from the start of construction to the commissioning of the plant. France, Finland and Slovakia are building new nuclear plants and in Eastern Europe new nuclear programs are underway. In the USA, this year the construction of two new technology projects AP-1000 will start. In China, currently 27 plants are being built, in India 6. Finally, in South America, countries like Brazil or Argentina are considering new nuclear programs.

Globalization of the economy and the growing presence of European companies in a variety of projects have contributed considerably to the need for qualified personnel within the sector. This Master’s programme aims to train qualified staff to fill the growing demand within the sector and society.

The programme focuses not only on training professionals to be highly prepared to reach positions of responsibility within the nuclear power sector, but also to train personnel to be able to do research and development or to work as teachers in this field.

AIMS

This Master’s course has been designed to help students:

- Achieve a deep understanding of the theoretical and practical fundamentals of nuclear engineering and the technology associated with power production via nuclear fission chain reactions.
- Have both a clear and broad vision of the energy transformation chain of nuclear fuel into its final useable form, from uranium mining to the management of used nuclear fuel.
- Learn the lifecycle of the different installations, from the initial construction to the decommissioning and dismantling of a nuclear facility.
- Have a profound understanding of regulation and nuclear safety.
- Develop a strategic view of the sector, and the ability to comprehend problems and to make decisions.

STUDENT PROFILE

This Master’s course is aimed at people with university level studies in technical sciences in the following areas:

- Engineering: Industrial Technologies, Materials, Power, Chemistry, Mechanics and Electricity
- Other engineering and technical engineering fields
- Physics, Chemistry

METHODOLOGY

The courses will combine theoretical and practice-based activities (demonstration classes, self-guided studies, using calculation codes and laboratory practice) with guided visits to different nuclear installations. An important part of the learning process for students will be combined problem solving via Project Based Learning (PBL) projects, working mostly in small cooperative groups.

ADMISSION REQUIREMENTS

University Master’s degrees are open to holders of an official Spanish university degree or holders of an official university degree awarded by a university that is part of the European Higher Education Area which allows access to Master’s degree courses in the country in which it was awarded.

University Master’s degrees are also open to holders of a university degree awarded by a university in a country that is not part of the European Higher Education Area, where this has been officially recognized as equivalent to a Spanish qualification that provides access to University Master’s degrees. If the applicant’s degree has not been officially recognized, the University must first verify that the course of study corresponds to a level of education equivalent to an official Spanish university degree and that the qualification obtained would provide admission to a Master’s degree in the country of award. Admission following this process under no circumstances implies the official recognition of the degree or its acceptance for any other purpose than admission to the Master’s degree course.
Programme

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**Fundamentals of Nuclear Engineering and Radiological Protection (9 ECTS)**
- Nuclear Physics
- Detection and Measurement of Radiation
- Fundamentals of Radiological Protection

**Nuclear Power Plants (15 ECTS)**
- Reactor Physics
- Thermal-hydraulics
- Systems and components
- Materials

**Fuel Cycle and Environmental Impact (6 ECTS)**
- The nuclear fuel cycle
- The environmental impact of nuclear installations

**Regulations and Safety (6 ECTS)**

**Management of Nuclear Power Plants (10.5 ECTS)**
- Design and Construction
- Operation of Nuclear Plants

**Elective Block (13.5 ECTS)**
Every year a series of optional courses will be offered and students should select 3 of them.
Among others, the following courses will be offered:
- Nuclear fusion
- New designs in fission reactors
- Instrumentation
- Non-destructive testing methods
- Monte-Carlo methods for radiation transport calculation

**Internship (15 ECTS)**

**Master’s Final Project (15 ECTS)**
Coordinator

Lluís Batet
PhD. in Engineering from the Universitat Politècnica de Catalunya. Associate Professor and current director of the Nuclear Engineering Section of the Department of Physics and Nuclear Engineering.

Lecturers

Lluís Batet
PhD. in Engineering from the Universitat Politècnica de Catalunya. Associate Professor and current director of the Nuclear Engineering Section of the Department of Physics and Nuclear Engineering.

Francisco Calviño
PhD. in Physics from the Universitat Autònoma de Barcelona. Professor of the Department of Physics and Nuclear Engineering at the UPC. Associate Researcher at the European Organization for Nuclear Research. Representative for the UPC at the Centro Nacional de Física de Partículas, Astropartículas y Nuclear (Spanish National Particle Physics, Astroparticles and Nuclear Physics Centre).

Guillem Cortes
PhD. in Physics from the Universitat Politècnica de Catalunya. Associate Professor of the Nuclear Engineering Section of the Department of Physics and Nuclear Engineering at the UPC. Research collaborator at the Institute of Energy Technologies (INTE) at the UPC.

Alfredo de Blas
PhD. in Engineering from the Universitat Politècnica de Catalunya. Associate Professor of the Department of Physics and Nuclear Engineering at the UPC. Chair Professor of the Department of Physics and Nuclear Engineering at the UPC. Representative for the UPC at the European Nuclear Education Network (ESES) that promotes the European Master of Science in Nuclear Engineering (EMSNE).

Javier Dies
PhD. in Engineering from the Universitat Politècnica de Catalunya. Chair Professor of the Department of Physics and Nuclear Engineering at the UPC. Representative for the UPC at the European Nuclear Education Network (ESES) that promotes the European Master of Science in Nuclear Engineering (EMSNE).

Mercè Ginjáume
PhD. in Physics from the Universitat Autònoma de Barcelona. Researcher at the Institute of Energy Technologies (INTE) at the UPC. Director of the Institute of Energy Technologies (INTE) [2005-February 2011]. Technical Director of the Dosimetry and Calibration Laboratory at the UPC.

Carme Pretel
PhD. in Engineering from the Universitat Politècnica de Catalunya. Vice Director of the Institute of Energy Technologies (INTE). Professor of the Department of Physics and Nuclear Engineering at the UPC.

Francesc Reventós
PhD. in Engineering from the Institut National Polytechnique in Grenoble, Associate Professor of the Department of Physics and Nuclear Engineering. Research collaborator at the Institute of Energy Technologies (INTE) at the UPC.

Josep Sempau
PhD. in Physics from the Universitat Politècnica de Catalunya. Researcher at the Institute of Energy Technologies (INTE) at the UPC.

Arturo Vargas
PhD. in Engineering from the Universitat Politècnica de Catalunya. Researcher at the Institute of Energy Technologies (INTE) at the UPC.

Maria A. Duch
PhD in Physics from the Universitat Politècnica de Catalunya. Researcher at the Institute of Energy Technologies (INTE) at the UPC. Head of the Radiological Protection Service and Technical Director of the Thermoluminescent Dosimetry Laboratory at the UPC.

This Master’s course includes the presence of prestigious internationally recognized visiting lecturers and expert professionals from Endesa and the Nuclear Energy sector.
**Degree**
Master’s Degree

**Duration**
90 ECTS

**Language**
English

**Course Dates**
September 2011 to January 2013

**Schedule**
From Monday to Friday in the evening

**Registration fee**
13,500 euros

**Taught at**
Escola Tècnica Superior d’Enginyeria Industrial de Barcelona (ETSEIB-UPC)
Av. Diagonal, 647
08028 Barcelona

**More Information**

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**Endesa Energy School**
Pablo Fernández-Olano
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pablo.fernandezolano@endesa.es

**ENDESA-UPC FINANCIAL AID PROGRAMME**

This Master’s course is financially supported by Endesa and there is an extensive scholarship programme available for prospective students. For more information http://formaciocontinua.upc.edu/nuclearengineering

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**ECTS**
European Credit Transfer System

The ECTS system allows for measurement of the specific work that must be completed by students to be able to obtain the knowledge, abilities and competencies needed to pass the different subject areas they are studying.

Each ECTS is equivalent to 25 hours of study and includes the time dedicated to in-class sessions, student work hours, tutoring sessions, seminars, exercises, internships and projects, as well as the time needed for preparing and taking exams and evaluations.

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**THE UPC INTO THE EHEA**

The UPC goes one step further to offer a high level of quality and excellence in its educational programmes by integrating their course offerings into the European Higher Education Area (EHEA).

Upon completion of the quality evaluation and accreditation process we give our students access to programmes that are fully recognised within the European market: The workload of all students is measured in ECTS (the European standard) and, follows the provisions in the Bolonia process, which is defined by the general and specific competencies that students will attain once they have passed their courses.
THE UNIVERSITAT POLITÈCNICA DE CATALUNYA

The Universitat Politècnica de Catalunya is a public research and higher education centre that specialises in architecture, sciences and engineering. The different faculties are reference centres both in Spain and internationally for research and training professionals and researchers. The University is strongly committed to providing high quality technical education to adequately respond to the educational needs that are required both in traditional and emerging productive sectors. We have 23 different schools and faculties involved in teaching, research and dissemination of knowledge.

One of these educational centres is the School of Industrial Engineering of Barcelona (ETSEIB) which combines both a longstanding tradition with a spirit of renewal and continuous improvement in order to become one of the best engineering schools in Spain and an internationally renowned educational centre.

The School maintains strong ties with the local industrial, financial and social sectors and can boast significant international presence and recognition.

Research and technology/knowledge transfer done in the different research departments, centres and groups at the School has helped it become a pioneer in many different scientific and technological areas and has helped the ETSEIB to foster a strong presence and involvement in industry. It is both specialised and well recognised in architecture, sciences and engineering.

The UPC offers degree programmes that fully integrate the changes required by the European Higher Education Area for Master’s and Doctorate degrees. In addition, the University permanently offers Master’s programmes and other courses that are adapted to professional development needs.

ENDESA ENERGY SCHOOL

Endesa aims to use talent to help the company face its most important scientific and technological challenges for their business in the future. Our university also shares their belief that talent is the driving force that will power future development of the knowledge economy.

Five years ago Endesa founded the Energy School at a time when the greatest challenges that would define the future path of the energy sector were becoming clearer. Global competition, declining energy sources, environmental problems, constantly changing regulations, economic crises, etc. During this period the university consolidated its position as Endesa’s corporate University by selecting and training professionals in order to face challenges and achieve desired improvements.

The Endesa Energy School believes in aligning education with needs that are generated by business strategies. We are developing innovative educational solutions based on advanced technologies using the Learning by Doing methodology. We are also trying to create an effective learning environment and we have set up agreements with the most renowned knowledge centres around the world. We wish to open knowledge up to collaborators, suppliers and those involved within the company environment.

Endesa, together with the Universitat Politècnica de Catalunya (UPC), has launched the Master of Nuclear Engineering with the goal of creating an environment that promotes the exchange of ideas and knowledge, a space where innovation and technology contribute to advances in the field of nuclear science and, in turn, will contribute to making the world a more sustainable place.