



POLITECNICO
MILANO 1863



MASTER OF SCIENCE IN ENERGY ENGINEERING



STRUCTURE OF THE STUDY PROGRAMME

One degree

Laurea magistrale in Ingegneria Energetica – Energy Engineering
Equivalent to Master of Science (M.Sc.)

Six tracks

- **Power Generation** (120 ECTS available in English – Milano Bovisa)
- **Termotecnica – Energy Use and Built Environment** (120 ECTS available in Italian – Milano Bovisa)
- **Oil and Gas Production** (120 ECTS available in English – Milano Bovisa)
- **Green Power Systems** (120 ECTS available in English – Milano Bovisa)
- **Renewables and Sustainability** (120 ECTS available in English – Piacenza)
- **Energy for Development** (120 ECTS available in English – Milano Bovisa)



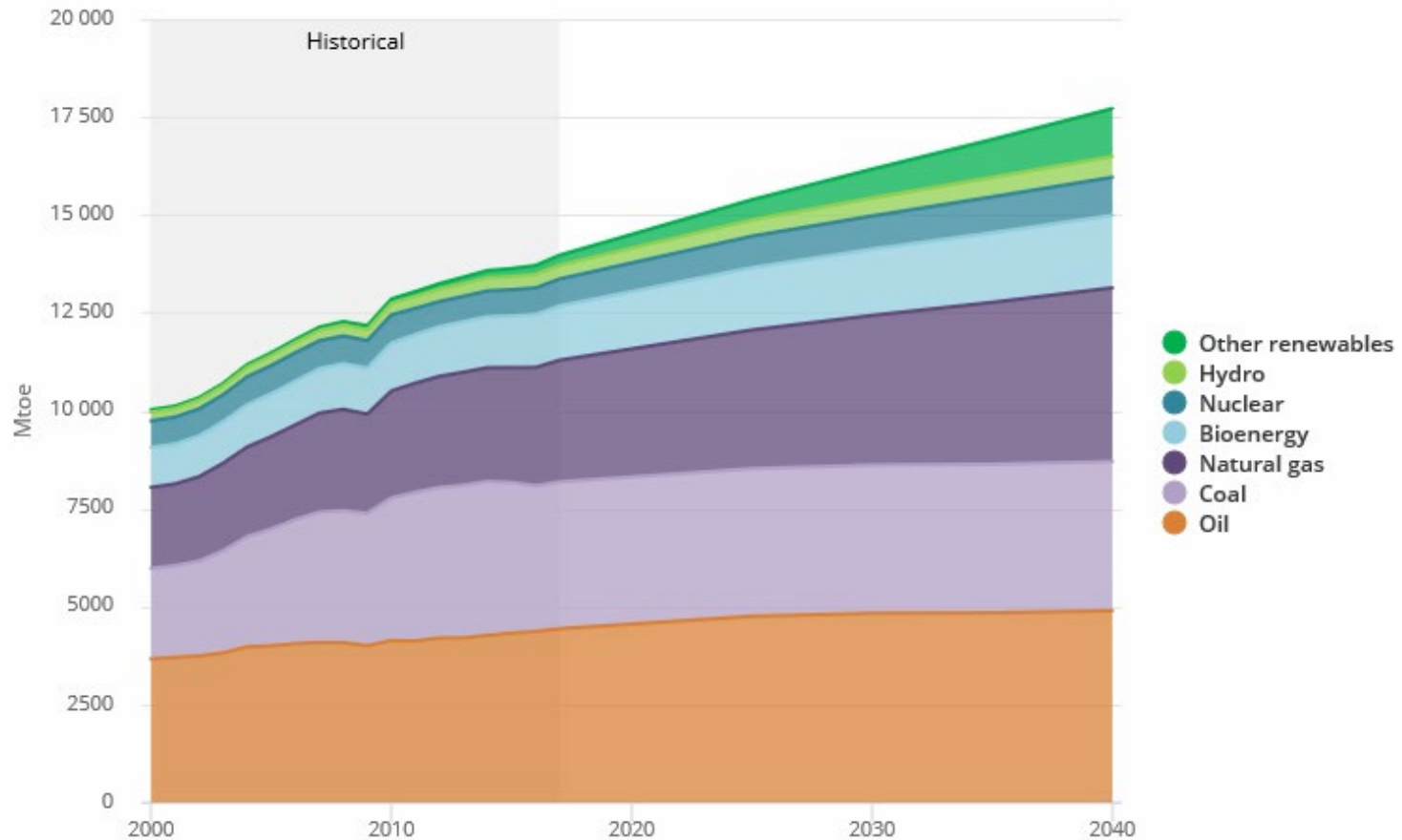
TEACHING ACTIVITIES

Overall ECTS: 120 = 100 Courses + 20 Thesis

- **Fundamentals (36 ECTS):** *common to all the tracks and available on free choice in English and in Italian*
 - Heat and Mass Transfer (10 ECTS)
 - Energy Conversion or Heating and Cooling Systems (10 ECTS)
 - Fundamentals of Chemical Processes (8 ECTS)
 - Electric Power Systems (8 ECTS)
- **Specialized (32 ECTS):** *giving the character of each track*
- **Interdisciplinary (32 ECTS):** *linking various engineering areas*
 - Guided choice in groups (24 ECTS)
 - Free choice (8 ECTS) among all the subjects of the Study Programme or in the Soft Skills group



POWER GENERATION: TOPICS



IEA/World Energy Outlook 2018



POWER GENERATION: TOPICS



Conventional power plants



Industrial processes



Turbomachines



Internal combustion engines



POWER GENERATION: SPECIALIZATION COURSES

Chemical processes and technologies

The course provides the bases of chemical and physical equilibria and on chemical kinetics, which are necessary for the understanding of unit operations and chemical processes relevant to applications in the energy field

Sistemi energetici avanzati

Il corso è incentrato sulla produzione di vettori energetici decarbonizzati (elettricità e idrogeno) da impianti fossili

Internal combustion engines/Turbomachinery B

The courses provide a physical and mathematical description of a four-stroke engine and the main turbomachinery



POWER GENERATION: LABORATORIES

Numerical and experimental laboratories at Department of Energy are of interest for **thesis purposes**, such as:

- MRT Fuel cells
- Laboratorio Computational Fluiddynamic
- Laboratory of Fluid-dynamics of Turbomachinery
- Laboratory of Micro-Cogeneration
- Laboratory of Internal Combustion Engines
- Catalysis and Catalytic Processes Laboratory



POWER GENERATION: JOB OPPORTUNITIES

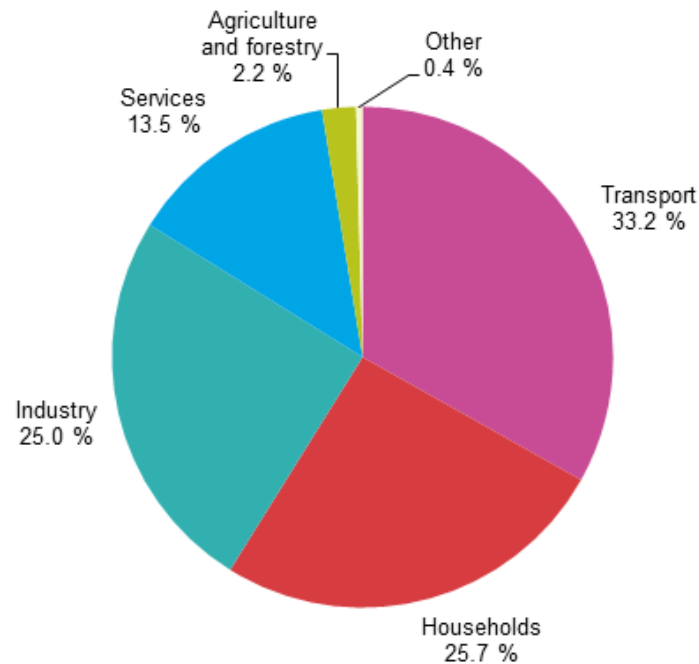
Design, construction, maintenance and managing engineers at

- power utilities
- energy and gas distributors
- engineering procurement and construction
- energy service companies
- manufacturing companies
- processes industries



TERMOTECNICA - ENERGY USE AND BUILT ENVIRONMENT: TOPICS

Final energy consumption by sector, EU-28, 2016
(% of total, based on tonnes of oil equivalent)



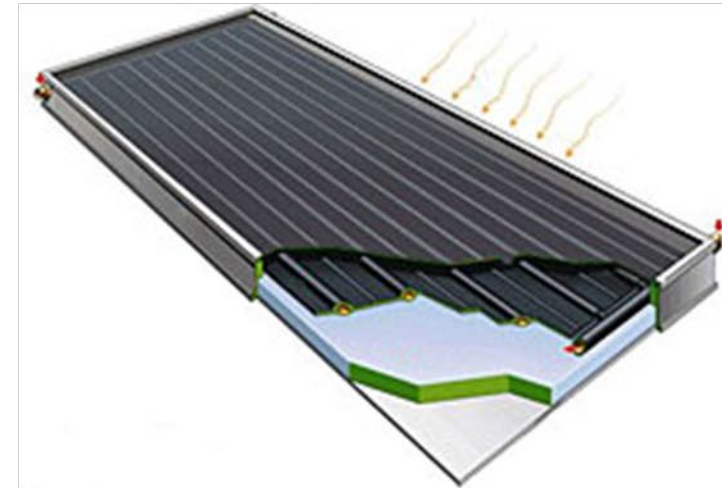
In 2016, households (i.e. the built environment) account for 25.7% of European end-use energy consumption

Source: Eurostat (online data code: nrg_100a)

eurostat 



TERMOTECNICA - ENERGY USE AND BUILT ENVIRONMENT: TOPICS



Efficienza energetica negli edifici (Energy efficiency for the built environment)

The course is aimed at providing the knowledge and the tools needed to design the envelope of high performance buildings (low energy consumption, high comfort quality)

Green building energy systems

The course is aimed at providing the knowledge needed to design a "green" building with reduced environmental impact while maximizing occupant health

Progettazione di impianti termici (HVAC systems design)

The course is aimed at providing the knowledge and the tools needed to design an HVAC system



TERMOTECNICA - ENERGY USE AND BUILT ENVIRONMENT: LABORATORIES

Wide variety of laboratories in which it is possible to carry out the final thesis

Both **fundamentals** (e.g. heat transfer during evaporation and condensation, materials for humidification/dehumidification, ground thermal response with groundwater flow etc.) and **applied** (e.g. refrigerants, compressor and heat pump performance, desiccant wheels, clean room, solar systems etc.) research activities

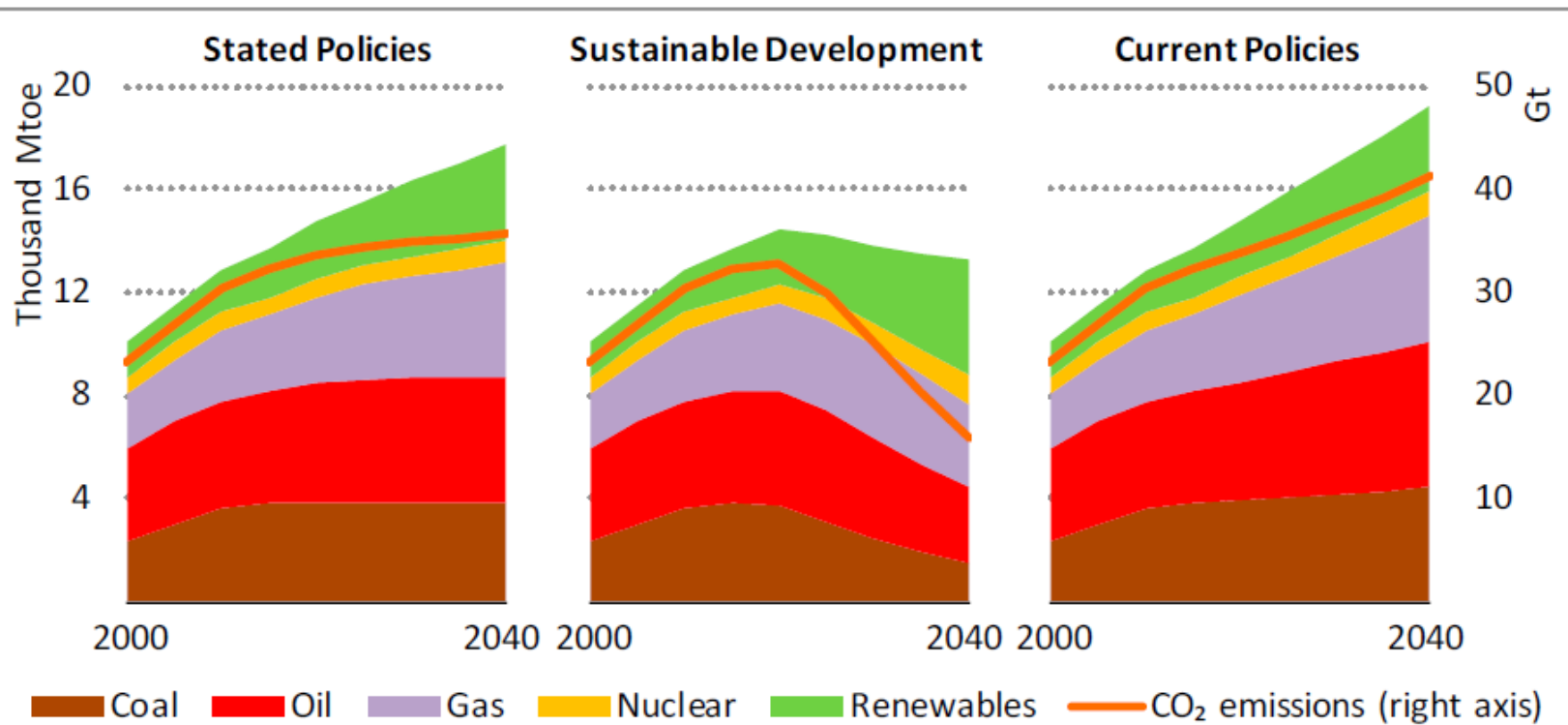


TERMOTECNICA - ENERGY USE AND BUILT ENVIRONMENT: JOB OPPORTUNITIES

- Freelance/consultant engineer in the field of HVAC systems design.
- Energy manager in medium and big companies.
- Project engineer/project manager in companies that manufacture HVAC components (boilers, heat pumps, chillers, fans, clean rooms etc...). Some example: Ariston, Aermec, Daikin, Euroklimat, Mitsubishi, Vaillant, Viessman, etc...



OIL AND GAS PRODUCTION: TOPICS



Source: World Energy Outlook 2019 (IEA)



OIL AND GAS PRODUCTION: TOPICS



Exploration



Production



Tranportation



Refining

OIL AND GAS PRODUCTION: SPECIALIZATION COURSES

Fundamentals of Oil and Gas engineering

This subject deals with geology, hydraulics and physics matters mainly, including the most advanced concepts of physics and chemistry of 2 and 3 phase reservoir systems

Transport Phenomena in petroleum reservoirs

The course will cover the basic processes associated with fluid flow in porous and fractured media, starting from Darcy's Law and its extensions to multiphase flows

Oil and Gas field development and production

The course will provide the basis for understanding how an oil or gas field is designed, developed and managed during the production life



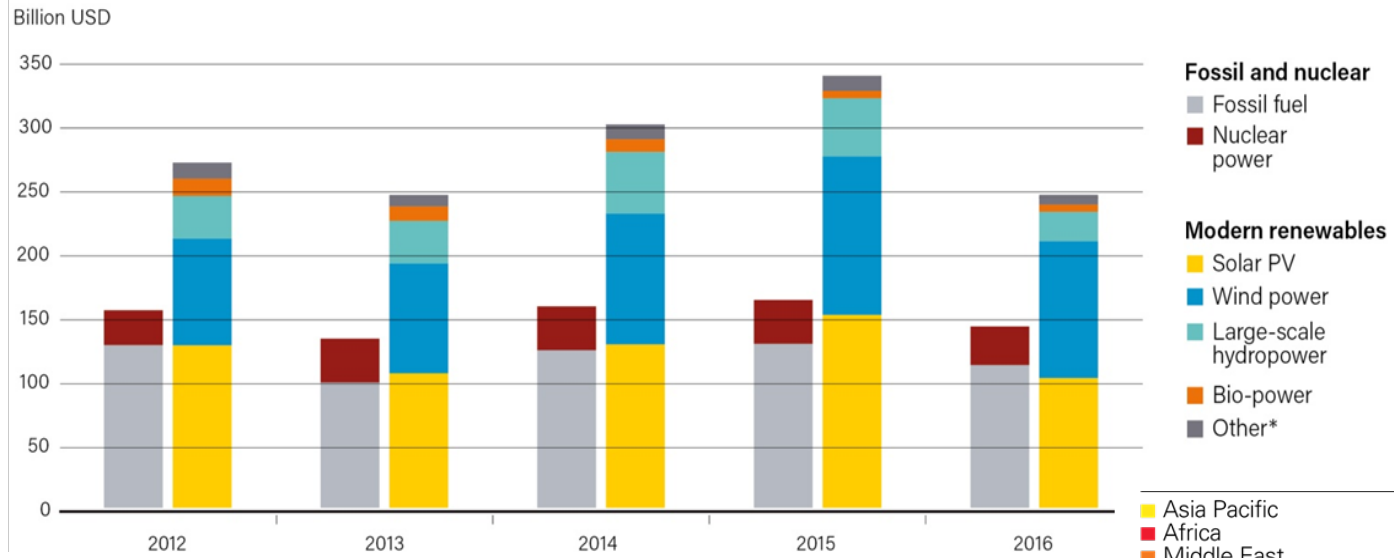
OIL AND GAS PRODUCTION: JOB OPPORTUNITIES

Design, construction, maintenance and managing engineers at

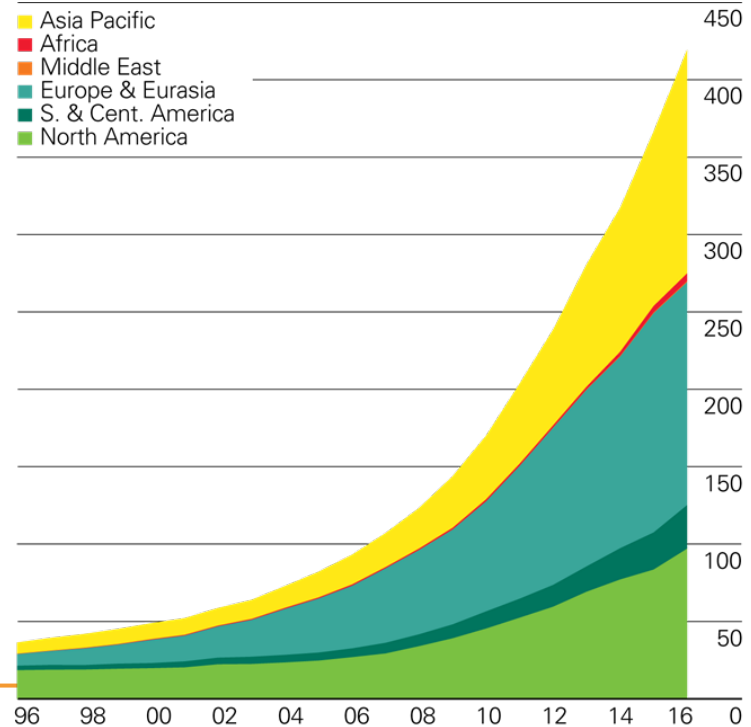
- oil and gas companies
- oil and gas service companies
- petrochemical industries
- chemical industries



GREEN POWER SYSTEMS: TOPICS



Modern renewables consumption by region
Million tonnes oil equivalent



GREEN POWER SYSTEMS: SPECIALIZATION COURSES

Wind, Hydro and geothermal power generation & Solar and biomass power generation

These courses provide the knowledge and the tools to correctly design renewable power systems

Electric conversion from green sources of energy

The goal of the course is to provide the fundamental elements of the energy conversion produced by renewable sources and their connection to the electric grid


Design of fluid machines for clean power generation

The course provides the necessary basic skills for the aerodynamic design and performance analysis of fluid machines in the frame of power production from renewable energy (i.e. wind and hydraulic turbines)



GREEN POWER SYSTEMS: FACILITIES

Experimental laboratories at Department of Energy are of interest for **thesis purposes**, such as:

- SolarTech Lab 
- MultiGood Microgrid Lab 
- Laboratory of Fluid-dynamics of Turbomachinery
- Catalysis and Catalytic Processes Laboratory



GREEN POWER SYSTEMS: JOB OPPORTUNITIES

- **Power utilities** (production, transportation and distribution of electricity, especially from renewable sources): ENEL Green power, ENI, A2A, Edison, Falck Renewables....
- **Energy engineering consulting companies** dealing with the design, construction, testing, operation and maintenance of (renewable) energy plants: Engie, ESE, Energy Team, Altran...
- **Companies producing machines and components** (wind turbines, heat exchangers, compressors, turbines, engines, boilers, refrigerators): Vestas, Siemens, Ansaldo, Bono Energia, Nooter Eriksen, Archimede Solar Energy,...
- **Energy Service Company (ESCO)**: A2A Energy Solutions, Cogeme, SIRAM,...
- As “**energy managers**” in companies and large energy users



RENEWABLES AND ENVIRONMENTAL SUSTAINABILITY: THE PIACENZA CAMPUS



- Very well-connected to whole Italy → Milano-Piacenza takes about 45'
- Limited number of Students per Teacher → teaching on a human scale
- Strong internationalisation → about 50% of RES students is foreign
- Strong collaboration with local companies → possibilities for stage-based MSc Thesis



RENEWABLES AND ENVIRONMENTAL SUSTAINABILITY: SPECIALIZATION COURSES

A MULTIDISCIPLINARY APPROACH combining energy, electric and environmental engineerings

Energy engineering courses as “Bioenergy and Waste-to-Energy Technologies” and “Renewable Energy and Low Carbon Technologies”

Electric engineering courses as Smart Grids and Regulation for Renewable Energy Sources

Environmental engineering courses as Air Pollution and Control Engineering and Industrial Ecology



RENEWABLES AND ENVIRONMENTAL SUSTAINABILITY: FACILITIES AND OPPORTUNITIES

- Large availability of classrooms and study spaces
- Campus open from 7.30 to 24.00
- Library open also Saturday and Sunday

LEAP Laboratory

(Laboratorio Energia-Ambiente Pc)

- Possibilities for developing Graduation Thesis
Experimental / Modelling works
- Use of commercial software
- In-house development of software
- Collaboration with national / international companies
- MatER Study Centre →



RENEWABLES AND ENVIRONMENTAL SUSTAINABILITY: JOB OPPORTUNITIES

- Multicultural classes (50% of RES students is foreign) → favour an open-mind approach toward international job opportunities
- Support from the local companies → favour the leap from academia to industry / consultancy already during the completion of the studies
- After one year from graduation, 50% of RES students are employed in large companies, whereas the remaining 50% in small/medium-size companies
- The type of jobs covers the entire spectrum of the energy sector, from R&D to commercial departments, in companies that produce either goods or services
- For top students, it is possible to candidate for a PhD position, in particular Polimi offers, among others, the Doctorate program in Energy and Nuclear Science and Technology (STEN)



ENERGY FOR DEVELOPMENT: TOPICS

Energy is essential to

- Socio-economic development
- Quality of life for the people
- Global security
- Environmental protection



SE4ALL

COP21 & COP22 ...

GOAL 7



Energy

Services

Development



ENERGY FOR DEVELOPMENT: SPECIALIZATION COURSES

Energy and climate change modeling and scenarios

The main objective of the course is to study climate change challenge in relation with the energy sector

Development economics

This course will provide the principle of development economics are key to understand the global challenges of development

Engineering and cooperation for development

The course aims at widening the vision of the students to design ad hoc energy solution that meet local needs and exploit local resources



ENERGY FOR DEVELOPMENT: OPPORTUNITIES

Opportunities within the energy for development track:

- Sustainable Energy System Analysis and Modelling
- Collaboration with NGOs
- Opportunities with the most relevant companies involved in the energy for development business



ENERGY FOR DEVELOPMENT: JOB OPPORTUNITIES

Energy and Development @ POLIMI

Professional Opportunities

Any position for Energy Engineers

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Energy Expert and Planner for Private Companies

- Eni, Enel, EDF, Edison, Res4Med

Energy Advisor within Company Sustainability Direction

- Eni, Enel, Edison, Marie Technimont

Energy Analyst for international organizations

- IEA, IRENA, UNEP, BEI, World Bank....

Energy Manager for non governmental organizations

- CEFA, ACRA, AVSI, COOPI, Lacor Hospital, COSV...

Consultant within Consultancy company

- PWC, Deloitte, BIT....



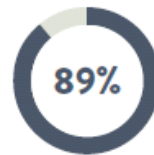
OCCUPATIONAL SURVEY 2019

EMPLOYMENT RATE*



* 1 year after graduation, except students

WITHIN 6 MONTHS*



* percentage calculated on those employed 1 year after graduation

NET MONTHLY SALARY

€1,621

EMPLOYEES



CONTRACT TYPE*



Permanent 50% ●
Fixed-term 16% ●
Apprenticeship 30% ●
Internship 1% ●
Other* 3% ●

* project based, occasional collaboration

COMPANY SIZE*



1 - 250 53% ●
251 - 1.000 14% ●
+1.000 33% ●

* number of employees

WHERE THEY WORK

Italian graduates working abroad 12%
International graduates working in Italy 67%

TOP 5 SECTORS

Energy, Oil & Gas 43%
Mechanics and Installation 17%
Metallurgy and Metalworking 6%
Business Consultancy 5%
Electronics and Automation 4%

TOP 5 AREAS OF EXPERTISE

Design 52%
Research and Development 23%
Planning 23%
Operations 14%
Commercial and Sales 14%



ADMISSION CRITERIA – 1

Students with a BSc from an Italian University
CFU-weighted average score $\geq SC$

- **Admission Threshold**
 - S : basic threshold
 - N : number of years from the first enrollment

$$SC = S + \frac{N - 3}{2}$$

- **Aerospace, Energy, Mechanical Engineering POLIMI** **S = 21**
 - Supplementary subjects for BSc professional tracks
- **Any Engineering POLIMI** **S = 25**
 - Supplementary subjects according to the Minimum Requisites Tables



ADMISSION CRITERIA – 2

Minimum Requisites for all tracks but EEE

Disciplinary area	ECTS
Mathematical analysis, Algebra, Geometry, Statistics	25
Numerical analysis	5
Fundamental and Applied Mechanics, Solid Mechanics	15
Physics, Chemistry ⁽¹⁾	15
Electrical machines, Computer Science, Control systems	10
Economics, Project and Programme Management	5
Thermodynamics, Heat transfer, Fluid mechanics, Chemical processes and technologies	15
Propulsion, Machine Design, Energy Systems,	15
Structural mechanics, Design and manufacturing, Plants, Materials	15
Total	120



ADMISSION CRITERIA – 3

Minimum Requisites for track EEE

Disciplinary area	ECTS
Mathematical analysis, Algebra, Geometry, Numerical analysis, Statistics	20
Physics, Chemistry	20
Fundamental and Applied Mechanics, Solid Mechanics, Structural mechanics, Design and manufacturing, Plants, Materials	25
Electrical machines, Computer Science, Control systems	15
Economics, Project and Programme Management, Research operations	10
Thermodynamics, Heat transfer, Fluid dynamics, Chemical processes and technologies, Propulsion, Machine Design, Energy Systems, Environmental Engineering	30
Total	120



CONTACTS

Website: www.ccs-energetica.polimi.it

Teaching rules: <https://www.polimi.it/corsi/corsi-di-laurea-magistrale/>

E-mail: energy-engineering@polimi.it

