DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

800 ANNI 1222 · 2022

UNIVERSITÀ DEGLI STUDI DI PADOVA

MASTER'S DEGREE IN ENERGY ENGINEERING

LAUREA MAGISTRALE INGEGNERIA ENERGETICA

Meeting with Advisory board

Davide Del Col, Anna Stoppato

Padova, 8 March 2022

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AGENDA

1)Presentazione del corso di studio

2) Presentazione degli insegnamenti

3) Richieste dagli stakeholders e discussione

4) Presentazione delle aziende agli studenti

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OBIETTIVI

-aggiornamento sulla nostra laurea magistrale

-consultazione sugli strumenti e i contenuti formativi forniti ai nostri studenti

SOME FIGURES

In 2021/22 we started our international master degree programme in Energy engineering (completely in English)

In the AY 2021/22 we have 114 students enrolled:
76 are italian students
38 are international students

For the AY 2021/22 we received around 800 applications from abroad

For the AY 2022/23 (first call) + 50% applications

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Countries of enrolled students AY 2021/22

AF Afghanistan
CY Cyprus
DE Germany
EG Egypt
ER Eritrea
ET Ethiopia
IN India
IQ Iraq
IR Iran
IT Italy
KG Kyrgyzstan
NP Nepal
PK Pakistan
RU Russia
SD Sudan
SY Syria
TN Tunisia
YE Yemen
ZM Zambia

This Master's Degree provides key skills to fulfil management and R&D roles in the *sustainable production*, *distribution* and *use* of energy in its various forms, whilst dealing with *environmental*, *economic* and *regulatory* aspects.

Professionals are also trained in renewable energy sources and main energy conversions, covering studies on cogeneration, combined and nuclear plants, energy in buildings, heating and refrigeration systems, biofuels and hydrogen as energy carrier...

The Programme has been awarded the EUR-ACE label (European Network for the Accreditation of Engineering Education), proof of a high-quality Engineering degree programme in Europe and abroad.

https://www.quacing.it/sistema-eur-ace
http://www.enaee.eu/

European Accreditation of Engineering Programmes EUR-ACE®

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ADMISSION REQUIREMENTS

- Bachelor’s degree (or higher) with proven skills in Mathematics, Physics, Chemistry, Thermodynamics, Heat transfer, Electrical and Mechanical engineering

- English language: B2 level (CEFR) or equivalent

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PROGRAMME STRUCTURE

This master degree foresees

69 CFU (credits) compulsory,
of which 51 in the 1st year and 18 in the 2nd year
3 CFU English B2 (Production skills)

15 CFU restricted choice (from a list of exams)
15 CFU free choice
18 CFU master's thesis

Furthermore:
this Master degree foresees 2 exams (15 CFUs) that can be chosen by each student among a limited list (constrained choice). This list depends on the profile selected by the student

1. ***Sustainable Energy Utilization***
2. ***Sustainable Power Generation***
3. ***Free profile***

There are 15 CFUs more that can be chosen freely by the student (autonomous choice), although a list of possible subjects is suggested depending on the profile

Finally, 18 more CFUs are obtained with the master's thesis.

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Master's degree Energy engineering

PROGRAMME STRUCTURE

This Master's degree programme foresees 9 *compulsory courses* (72 CFUs in total)
7 exams are in the first year, 2 exams are in the second year

Year	Sem	Subject	CFU	Hours
1	1	Measurements and Instrumentation	9	72
1	1	Applied Energy	9	72
1	1	Energy Systems	9	72
1	2	Combustion	6	48
1	2	Electric Power Systems	9	72
1	2	Heat Transfer and Thermofluid Dynamics	9	72
2	1	Renewable Energy Technologies	9	72
2	1	Energy Economics	9	72
1		English Language B2 (Productive Skills)	3	

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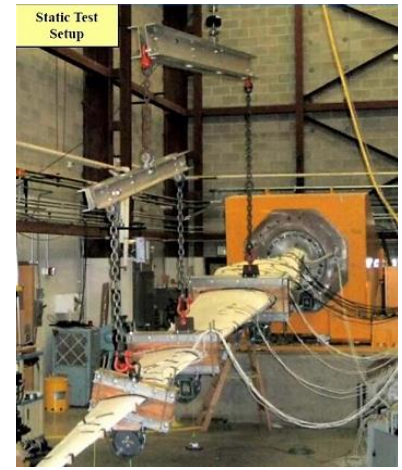
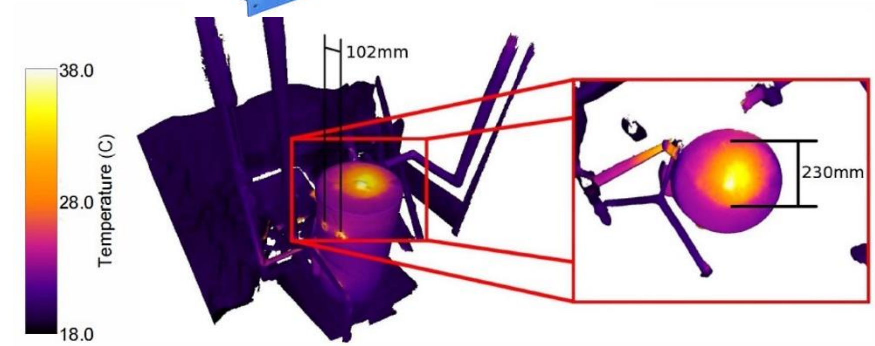
Measurements and instrumentation

GOALS: to provide criteria for instrument selection and methods for their correct use and for the critical evaluation of measurement results.

METHODS: Class and laboratory activities with PC-based data acquisition and processing systems.

CONTENTS:
Static and dynamic characterization of a measuring instrument; uncertainty analysis; operating principle and metrological characteristics of the most used instruments for energy engineering.



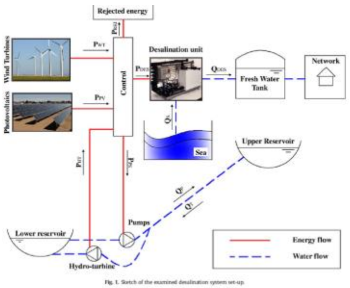


Applied Energy

GOALS: Acquire familiarity in the field of energy use in industrial plants. Provide analysis criteria based on the use of LCA techniques and Circular Economy concepts.

METHODS: frontal lessons, lessons in the computer lab, individual exercises, technical visits

CONTENTS: basic concepts on nuclear plants, elements of gas technology, nexus between water and energy, energy distribution through hydraulic circuits in industry, LCA



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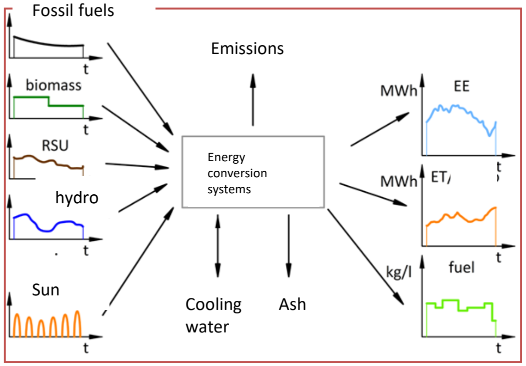
Energy Systems

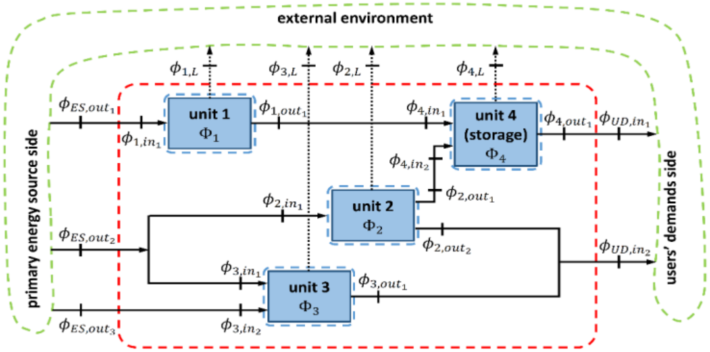
GOALS: Construction of models for predicting the design and off-design performances of renewable and traditional energy conversion systems

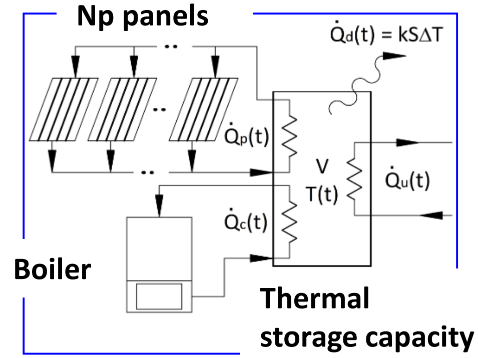
METHODS: Lectures and exercises in computer lab

CONTENTS:

- Simultaneous and sequential approaches
- Design and off-design models of the main energy systems components (turbomachines, heat exchangers, ..) and power plants in EES ® (simultaneous approach) and Matlab-Simulink ® (sequential approach) environment
- Exergo-economic analysis, optimization of heat exchangers networks, innovative methods for the design optimization of complex energy systems configurations







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Combustion

Goals

Understand physical and chemical mechanisms controlling fuels oxidation

Methods

Traditional and on-line lessons (in english), online self-evaluations, tours to local companies

Contents

- Constraints to internal energy conversion into heat
  1) thermodynamics 2) chemical kinetics 3) rate of heat and mass transfer
- Premixed (gas) flames
- Diffusive flames of gas, liquid or solid fuels
- Emissions control

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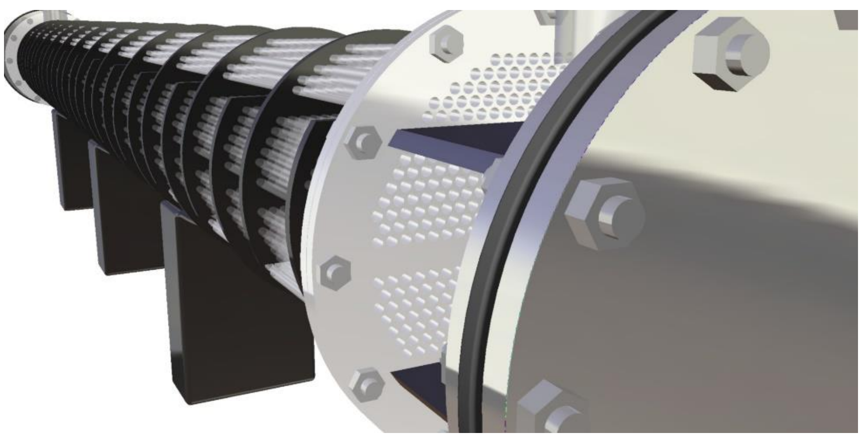
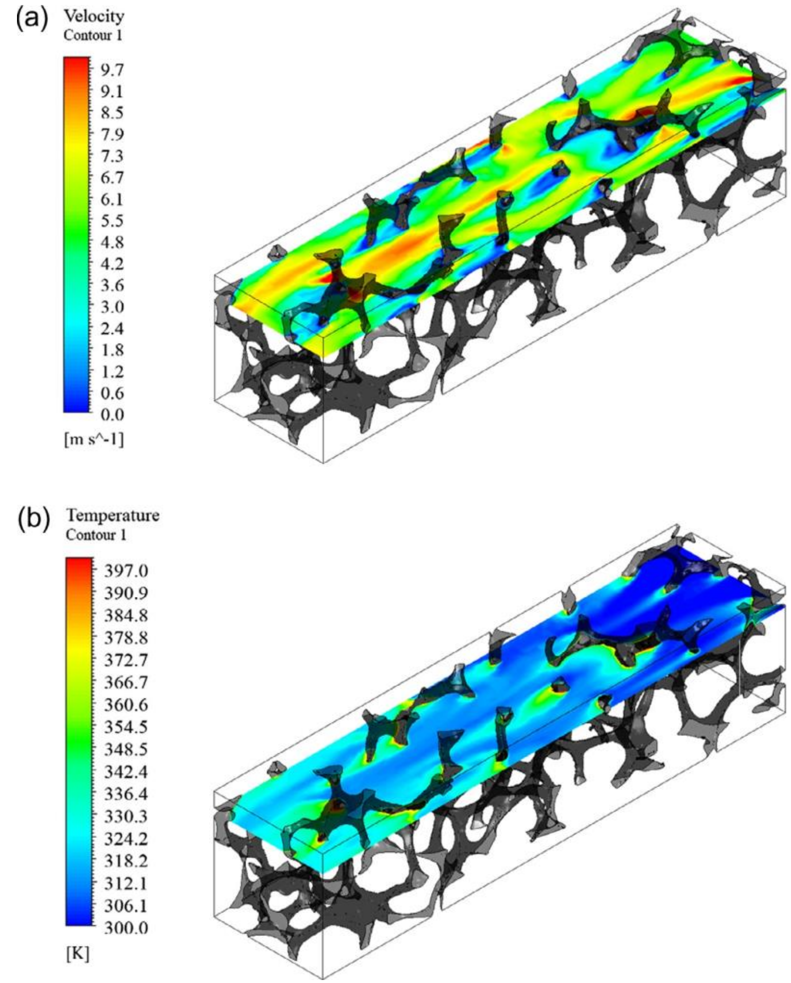
Heat Transfer and Thermofluid Dynamics

OBJECTIVES: Heat exchangers DESIGN and FINITE ELEMENTS analysis with computer.

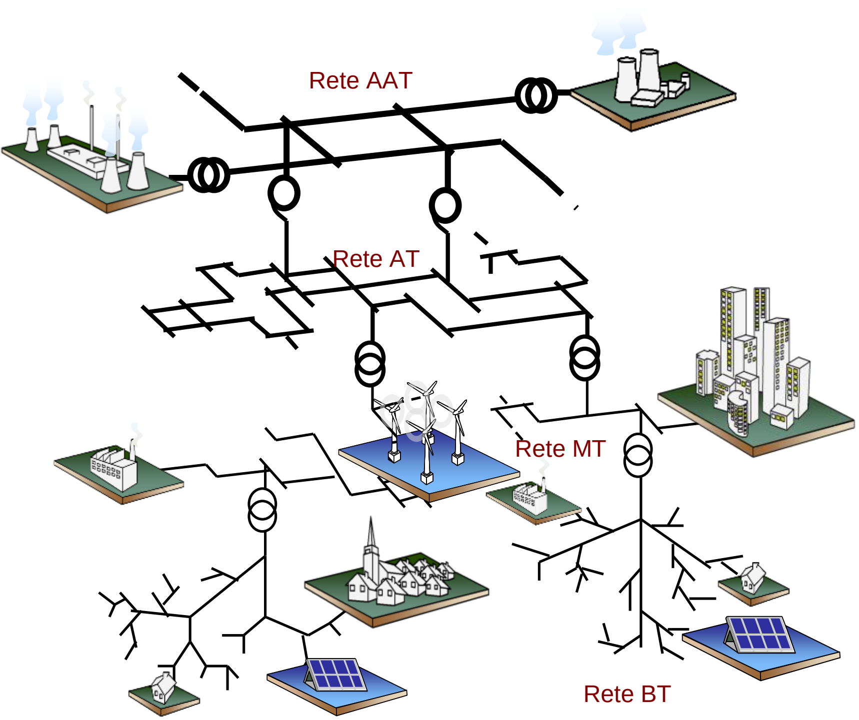
METHODS: lectures, LABORATORY, TEAM WORK: design of a heat exchanger

CONTENTS: single phase heat transfer, condensation, boiling, numerical methods. Heat transfer enhancement.





Electric Power Systems



GOALS: Acquisition of the knowledge bases for the constitution and operation of a large electrical system. Methods of analysis in the various functional regimes.

METHODS : Lectures, informatic lab exercises

CONTENTS:

- Structure of a Power System.
- Transmission Lines.
- Power Flows analysis.
- Reactive Power and Voltage Control (Voltage stability and Voltage collapse).
- Active Power and Frequency Control (Steady state and Transient System stability).
- Stability of interconnected systems.
- Overcurrent and Overvoltage System Protection.

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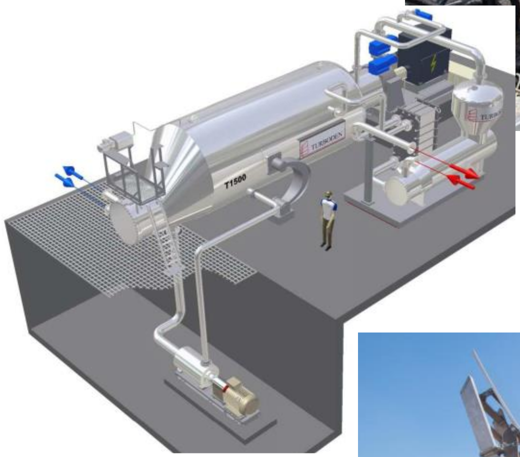
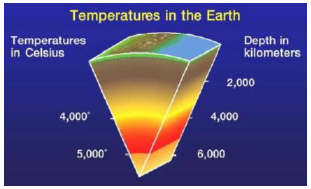
Renewable Energy Technologies

GOALS: provide advanced knowledge on technologies and systems for the exploitation of renewable sources

METHODS: lectures, numerical exercises, sizing of plants, solar energy laboratory, project work

CONTENTS:
- solar radiation, solar thermal systems, photovoltaic systems, solar cooling
- geothermal systems, geothermal plants for power generation, geothermal heat pumps
- wind energy, exploitation of solid biomass





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Energy Economics

Target : Achieving a basic knowledge of energy markets and evaluating energy investments. The student will be able to make a market analysis and to manage a project from the economic and technical perspective

Examination methods: Written exam during the course, oral exams along the year

Course contents: Energy sector basic knowledge. Exaustible resources economic analysis, the Hotelling rule, the role of financial markets. Prices and market of fossil fuels. Market equilibria under competition, oligopoly and monopoly. Economic evaluation of energy investments; the role of uncertainty. The electricity sector, organization and operation.

Master's degree Energy engineering

PROGRAMME STRUCTURE

This Master degree foresees 2 exams (15 CFUs) that can be chosen by each student among a limited list (constrained choice). This list depends on the profile selected by the student

1. ***Sustainable Energy Utilization***
2. ***Sustainable Power Generation***
3. ***Free profile***

There are 15 CFUs more that can be chosen freely by the student (autonomous choice), although a list of possible subjects is suggested depending on the profile

Finally, 18 more CFUs are obtained with the Master's thesis and final exam.

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Master's degree Energy engineering

PROGRAMME STRUCTURE

Profile: Sustainable Energy Utilization

Courses for constrained choice
15 CFUs *must* be taken among these subjects

Subject	CFU
Green Power Conversion and Utilization	6
Heating Ventilation Air Conditioning Systems	9
Energy and Buildings	6
Refrigeration and Heat Pump Technology	9

Courses for autonomous choice
15 CFUs *can* be taken among these subjects

Subject	CFU
Advanced Control Systems	6
Cogeneration and Combined Plants	6
Green Power Conversion and Utilization	6
Heating Ventilation Air Conditioning Systems	9
Energy and buildings	6
Refrigeration and Heat Pump Technology	9
Laboratory of Computational Thermo-Fluid Dynamics	3
Laboratory of Energy Audit	3
Laboratorio di Termodinamica Applicata	3

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Master's degree
Energy engineering

PROGRAMME STRUCTURE

Profile: Sustainable Power Generation

Courses for constrained choice
15 CFUs *must* be taken among these subjects

Subject	CFU
Nuclear Fission and Fusion Plants	9
Cogeneration and Combined Plants	6
Green Power Conversion and Utilization	6
Biofuels and Sustainable Industrial Processes	6
Wind and Hydraulic Turbines	9

Courses for autonomous choice
15 CFUs *can* be taken among these subjects

Subject	CFU
Advanced Control Systems	6
Green Power Conversion and Utilization	6
Cogeneration and Combined Plants	6
Nuclear Fission and Fusion Plants	9
Process technologies for carbon-neutral fuels	6
Wind and Hydraulic Turbines	9
PV science and technology	6
Laboratorio di Termodinamica Applicata	3
Laboratory of Computational Thermo-Fluid Dynamics	3
Design and optimization of sustainable energy systems	6

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Master's degree Energy engineering

PROGRAMME STRUCTURE

Profile: Free

Courses for constrained choice
15 CFUs *must* be taken among these subjects

Subject	CFU
Nuclear Fission and Fusion Plants	9
Cogeneration and Combined Plants	6
Green Power Conversion and Utilization	6
Biofuels and Sustainable Industrial Processes	6
Wind and Hydraulic Turbines	9
Heating Ventilation Air Conditioning Systems	9
Energy and buildings	6
Refrigeration and Heat Pump Technology	9

Green Power Conversion and Utilization

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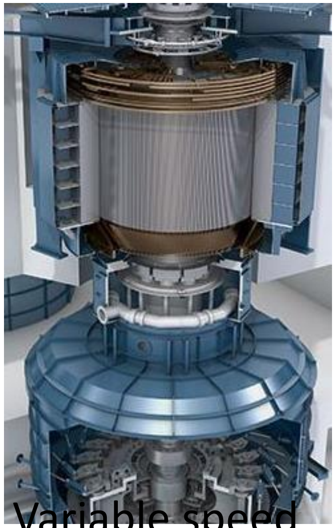
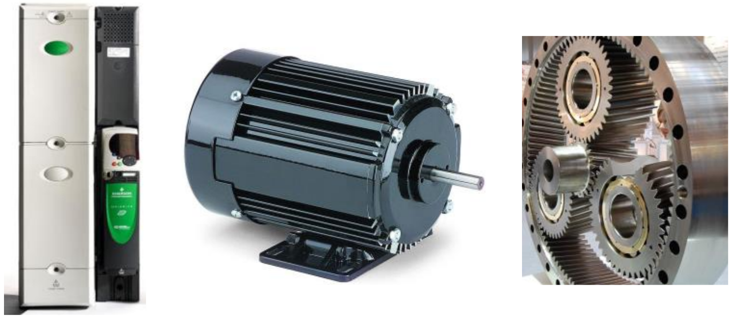
Goals:
understanding the operating principles and the main characteristics of electric drives for a sustainable power conversion and utilization.

Methodology:
classroom lessons and practical lab sessions

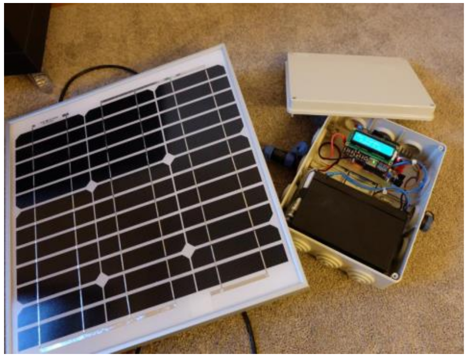
Topics:
Electric power conversion (inverter/rectifiers) and suppling of electrical machines by means of power converter (electric drives). Grid connection of renewable resources. Efficiency improvement adopting variable speed electric motors and generators.



Variable speed hydroelectric power plant



Main components of an electric drive



Grid connection of PV systems

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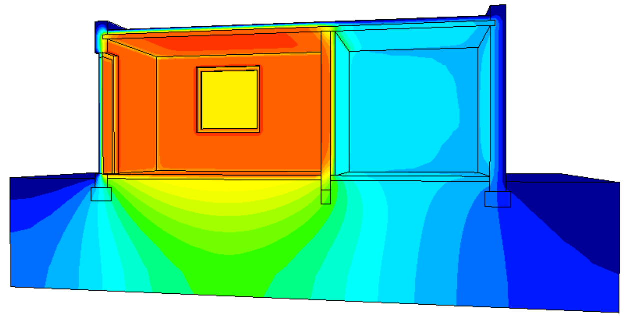
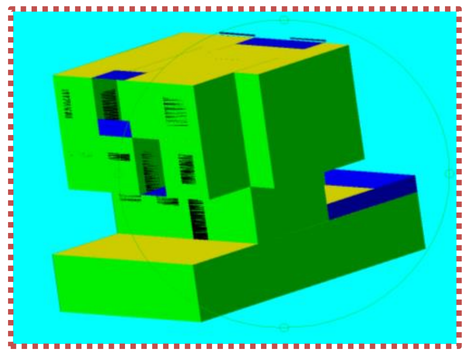
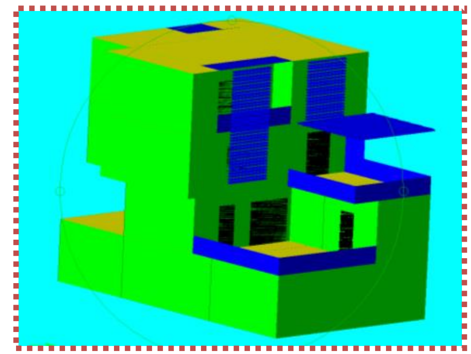
Energy & Buildings

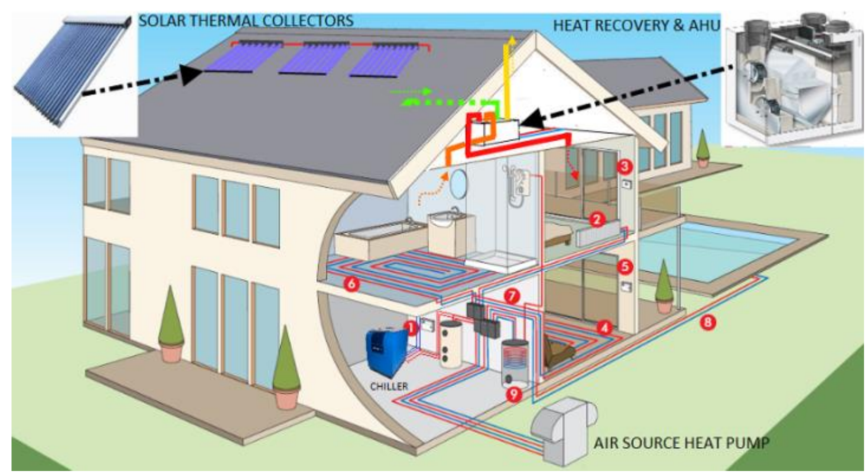


Goals: Learn energy consumptions in buildings and how to reduce them





Methods: Theory and practice. Use of tools: 2-D conduction in walls and 3-D dynamic simulation of the building with SKETCHUP and ENERGYPLUS. Write a report.



Contents: comfort (thermal and visual), energy balance of a building, energy consumptions in buildings, Building Managememt Systems, Zero Energy Buildings, Plus Energy Buildings, multi-source systems, energy in districts

Heating Ventilation Air Conditioning Systems

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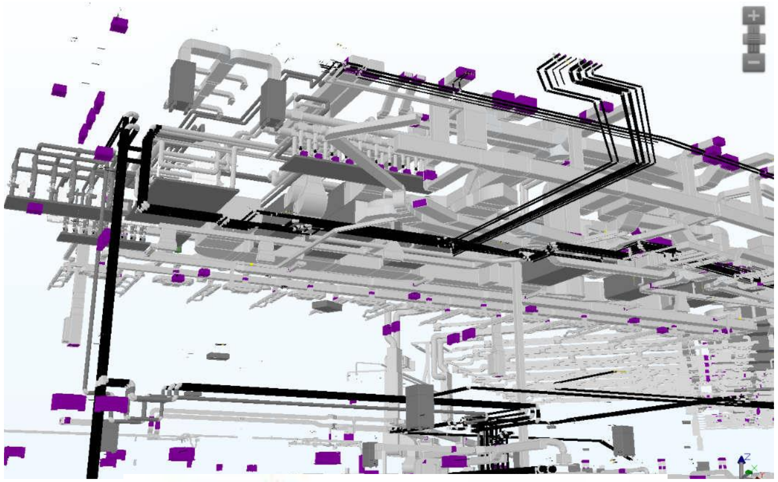
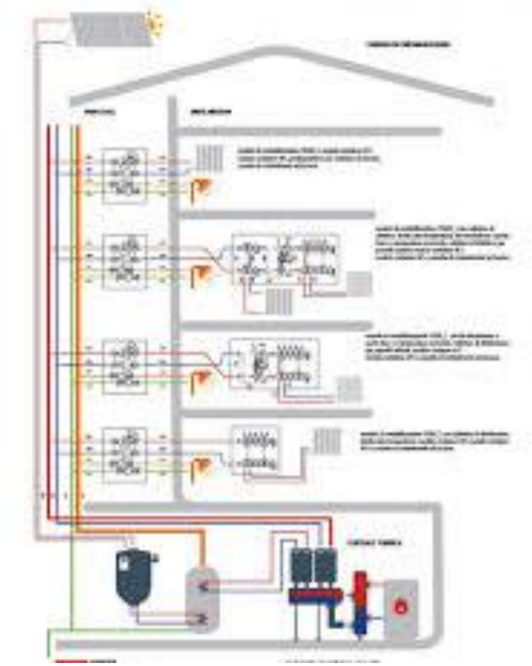
Goals: Learn the sizing and operation of hydronic and aeraulic systems for heating and cooling applications



Methods: Theory & practice. Excel and Word: calculation sheets on air handling units (AHU), size of radiant systems, balance hydronic circuits. Write a report.



Contents: Ventilation & IAQ, sizing a ventilation system, AHU components. Emission systems (radiators, radiant systems, etc.), tanks, valves, control, hydronic systems sizing and balancing. Management and sizing of boilers, heat pumps and chillers. District networks

Refrigeration and Heat Pump Technologies

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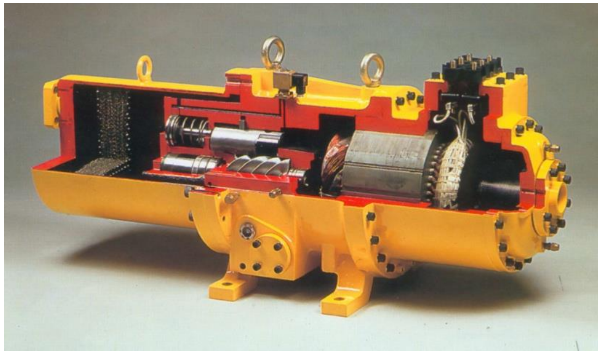
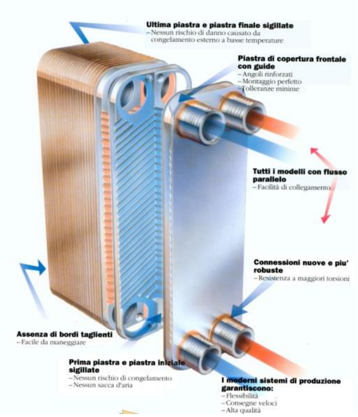
GOALS: study of systems and components for refrigeration and heat pump applications

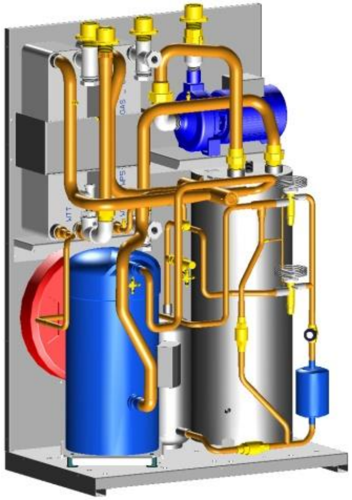
METHODS: lectures, laboratory, project work

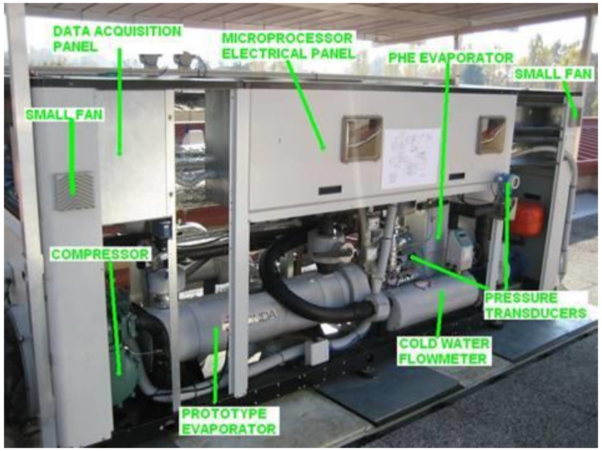
CONTENTS:

- analysis and selection of components depending on application
- adoption of new low-GWP refrigerants
- design of heat pumps, A/C and refrigeration equipment
- refrigeration and heat pump systems using CO_2 as the refrigerant









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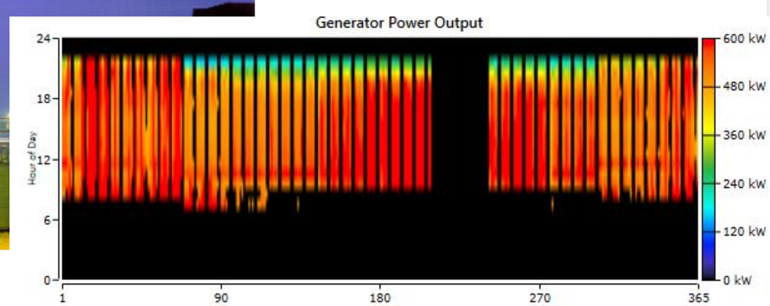
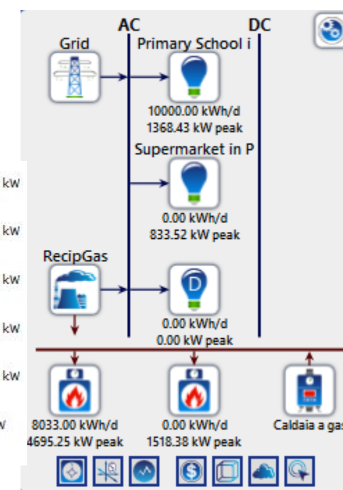
Cogeneration and Combined Plants

GOALS: Acquire familiarity with the main characteristics of combined cycle gas turbines and CHP systems, their design and operation

METHODS: frontal lessons, lessons in the computer lab, individual exercises, group projects, technical visits

CONTENTS: Gas Turbine Combined plants, Combined heat and power plants, sizing and management of cogeneration systems for residential and industrial users





Process technologies for carbon-neutral fuels

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GOALS: study and assess industrial processes for sustainable fuel production, CO_2 capture, sustainable hydrogen production

METHODS: lectures, analysis of case studies, teamwork

CONTENTS:
- Biofuel production processes
- Carbon capture, utilization, and sequestration
- Hydrogen production
- Sustainable industrial scenarios: water footprint reduction, e-refineries, carbon-negative production systems
- Ethics and social responsibility in engineering

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Wind and Hydraulic Turbines

Subject Description: ***DESIGN*** and ***OPTIMIZATION*** of wind and hydraulic turbines in the context of a mini and micro production. ***PREDICTION*** of operating conditions even by Computational Fluid Dynamics (CFD) at real operating conditions.

Methods: Frontal lectures in English, group ***PROJECT***

Course Outline

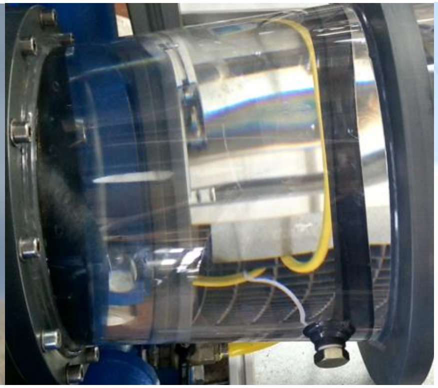
Studies and analyses of urban, suburban and off shore sites

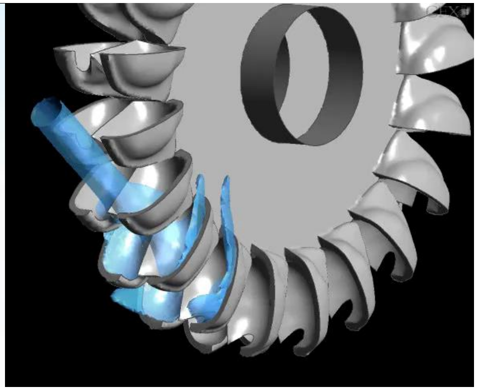
Design criteria for horizontal, vertical axis Wind Turbines and DAWT solutions.

Hydraulic Turbine design criteria focused on the solutions of mini plants (up to 10 MW) with low environmental impact and fish-friendly solutions.

Evaluation of operating conditions, even non-stationary and/or for ancillary network regulation.

Fluid dynamic analyses by computer analysis (ANSYS).



Photovoltaic Science and Technology

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OBJECTIVES: Understanding the working principles and the manufacturing processes of photovoltaic devices, design PV plants and exploit their maximum efficiency

METHODS: frontal lessons, Laboratory, homeworks and group Project

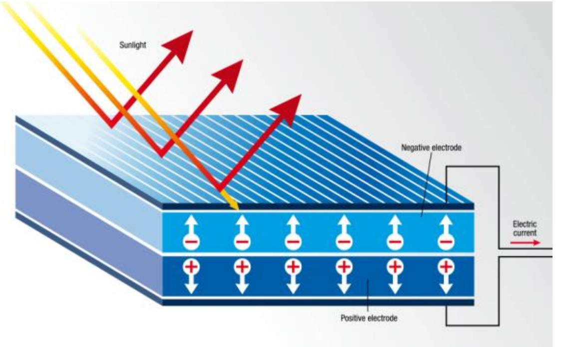
CONTENTS:

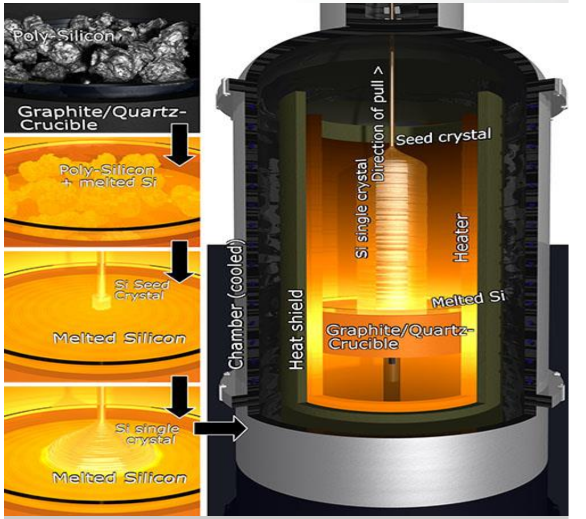
PV science The solar radiation and analysis of the spectrum.

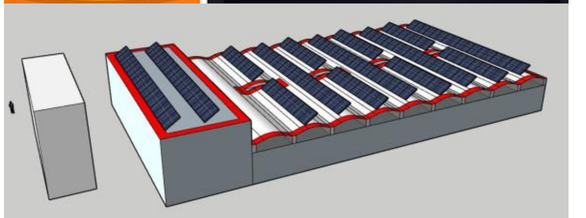
Detail analysis of the working principle and building blocks of solar cell.

PV technologies Solar cell and PV module anatomy. Silicon and thin film technologies, from raw material to final product, new photovoltaic technologies

PV design Design of PV plants and maximization of their efficiency and economical analysis







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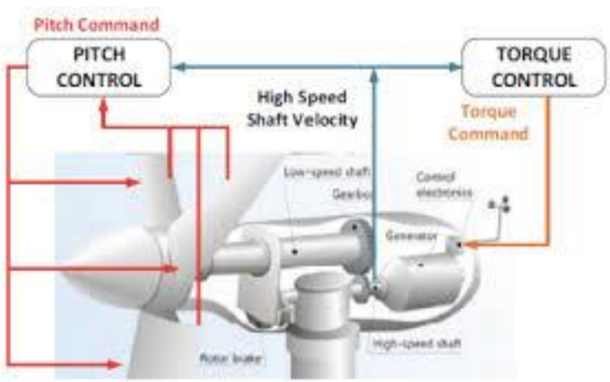
Advanced control systems

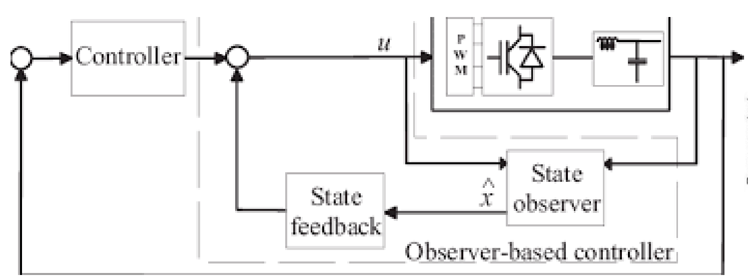
OBJECTIVES: Design of advanced feedback control systems for SISO and MIMO plants, in continuous- and discrete-time

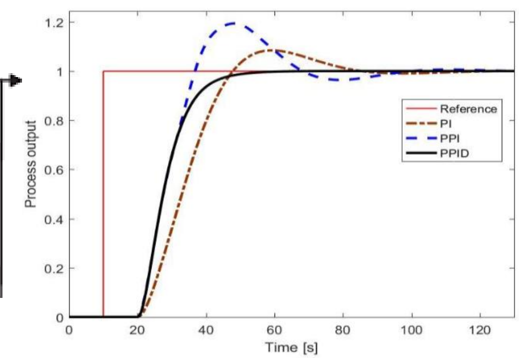
TEACHING METHODOLOGIES: Lecturing at the blackboard, aided by slides and Matlab/Simulink simulations

CONTENTS

Advanced PID control architectures
Discretization of continuous-time controllers
Observer-based controllers in state space for MIMO plants
Optimal control







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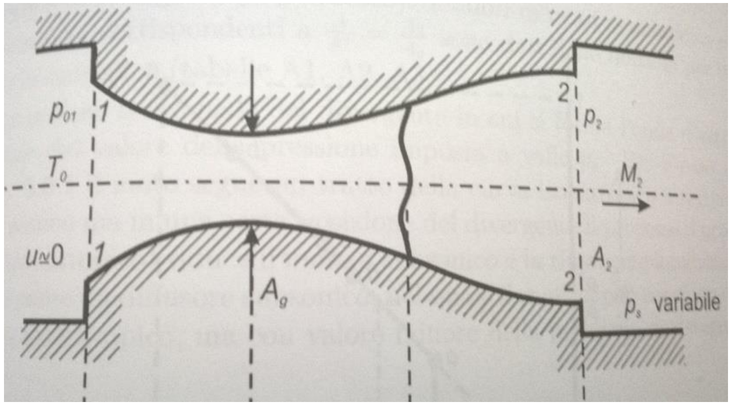
Laboratorio di Termodinamica Applicata

OBIETTIVI: Conoscenza di elementi di gasdinamica monodimensionale

METODI: lezioni frontali (18 ore) con svolgimento di esercitazioni di gruppo (6 ore).

CONTENUTI: Elementi di gasdinamica monodimensionale: velocità del suono, numero di Mach, moto isoentropico in condotti a sezione variabile, ugelli e diffusori subsonici e supersonici, onde d'urto normali ed oblique, moto adiabatico con attrito e moto con scambio termico in condotti a sezione costante (18 ore).



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Laboratory of Computational Thermo-Fluid Dynamics

NEW: it will start next academic year

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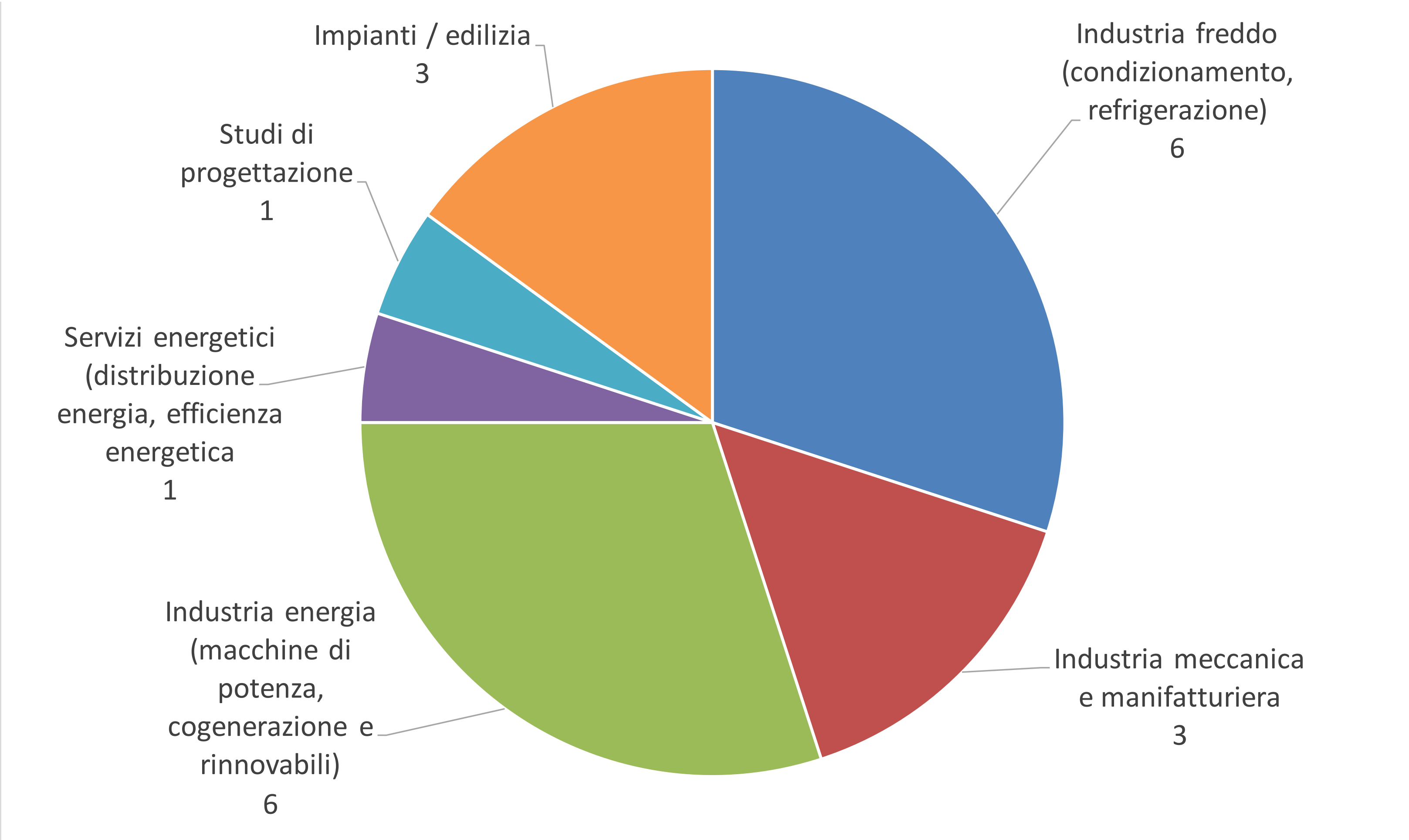
Aziende che hanno aderito



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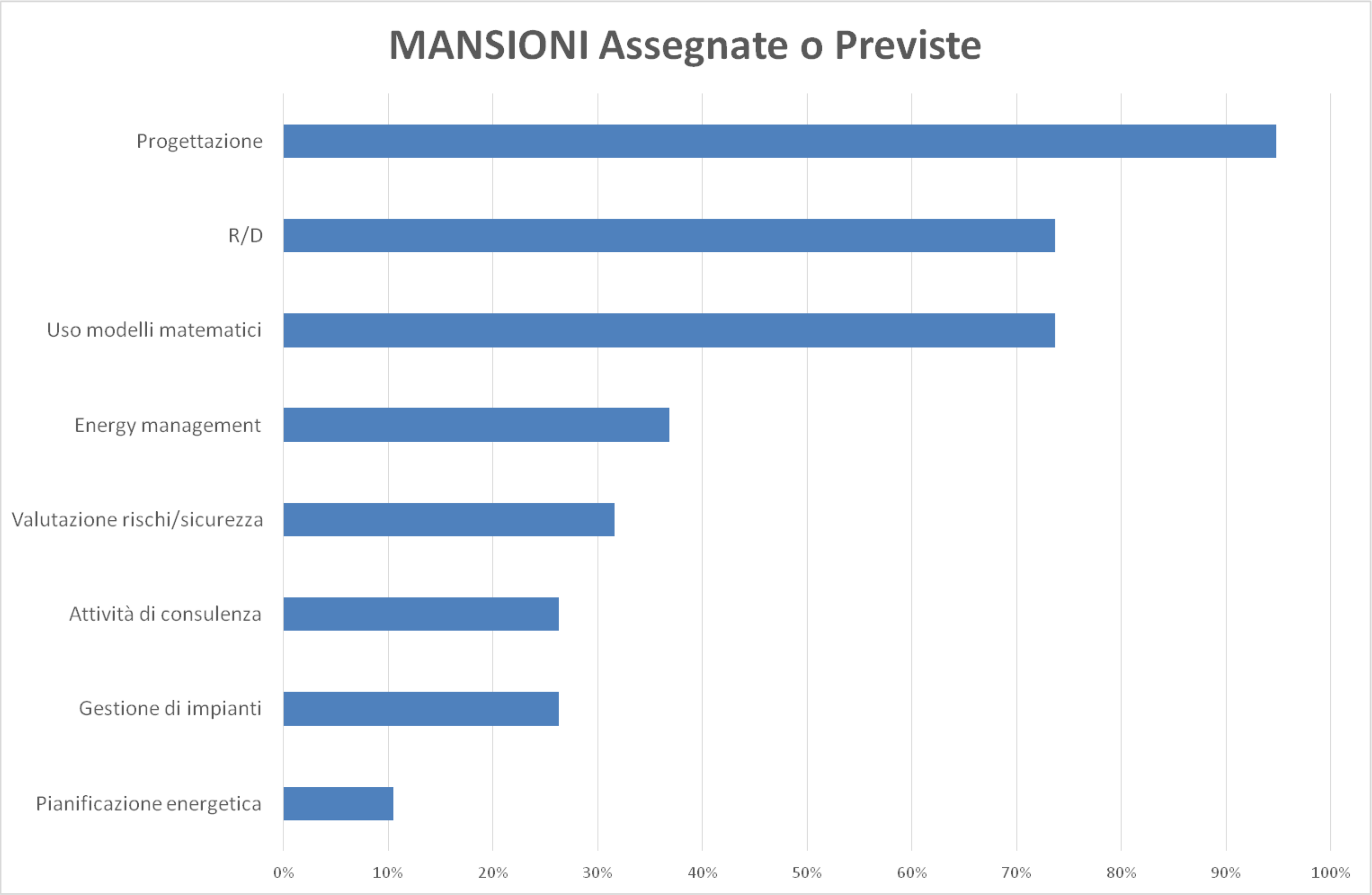

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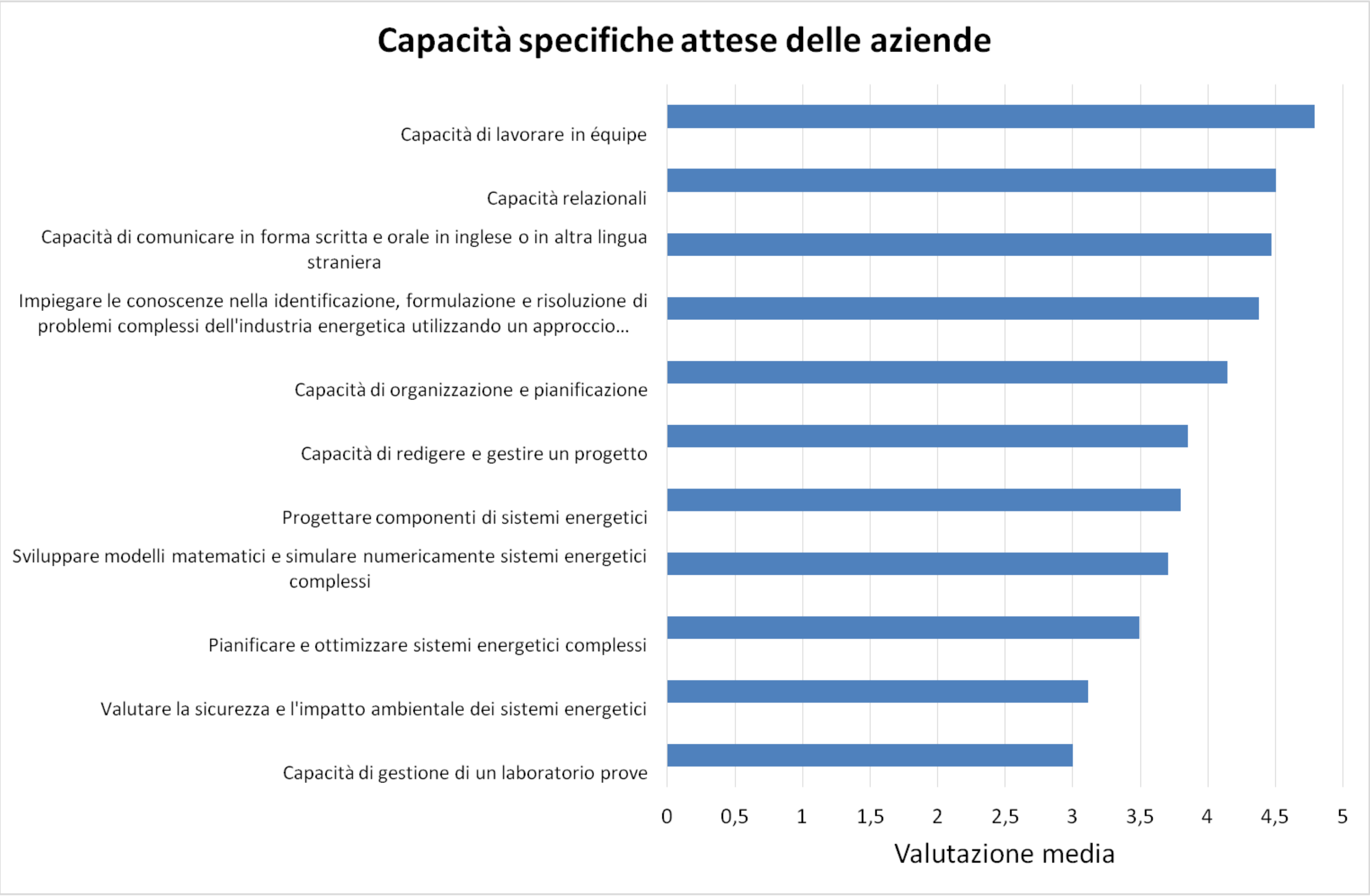

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