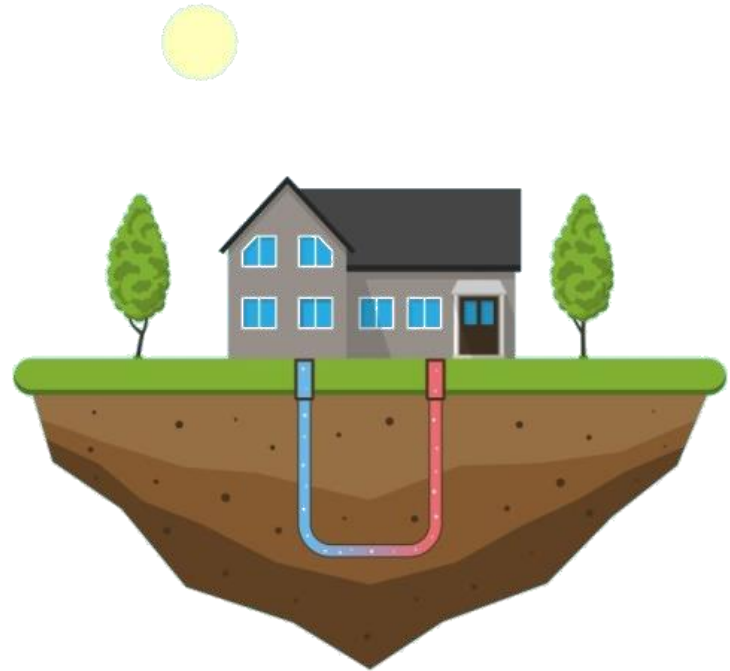
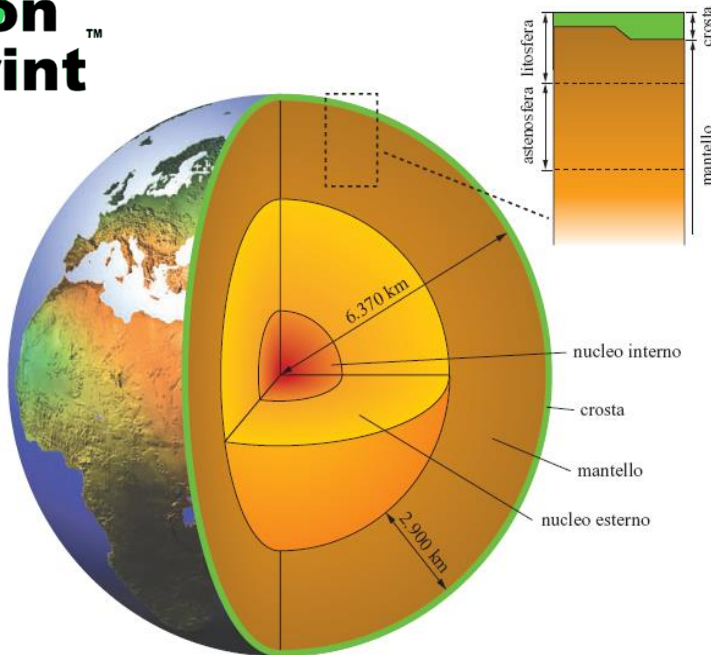


Geothermics Course 2025-2026



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Geothermics Course 2025-2026

Course description

In the field of renewable energies, the course is devoted to the geothermal resources.

The program will highlight the origin and dynamics of geothermal resources and fluids and the main exploration and exploitation technologies aimed to their use.

It will consider both high and low enthalpy systems in terms of origin, behavior, potential and real uses, environmental and economic benefits and impacts.



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Course First Part Outline - HIGH ENTALPHY GEOTHERMAL SYSTEMS:

1. Thermal conditions of the early Earth and present-day Earth's structure
2. Thermal parameters of the rocks and heat transfer processes
3. Thermal structure of the lithospheric continental areas (steady state)
4. Thermal structure of the lithospheric oceanic areas
5. Thermal structure of the lithosphere for transient conditions in various tectonic settings
6. Heat balance of the Earth
7. Thermal structure of the sedimentary basins
8. Thermal maturity of sediments
9. Mantle convection and hot spots
10. Magmatic processes and volcanoes
11. Heat transfer in hydrogeological settings
12. Geothermal Systems



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Course Second Part Outline - LOW ENTALPHY GEOTHERMAL SYSTEMS:

1. Introduction to Geoexchange plants
2. Types of GSHP Systems
3. Thermal response tests on field
4. Design and planning of a GSHP Plant
5. Closed loop Systems
6. Open loop Systems
7. Ground Thermal Modelling in steady state and transitory conditions
8. Applications of Deep Closed Loop solutions and Closed loop in Volcanic areas
9. New no-contact Geothermal drilling techniques
10. Underground heat storage systems
11. Underground food storage
12. New generation of Reuse of ex Oil and Gas wells as Geothermal



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Geothermics Course 2025-2026

Expected Learning Outcomes

At the end of the course students should know the main principles related to high and low enthalpy geothermal energy systems, the main techniques of the geothermal exploration and the technologies for their exploitation in several environmental, territorial and geological contexts. Through practical exercises and field trips students will be involved in the processes of resources estimation and in the design and sizing of the geothermal plants.

Pre-requirements

Intermediate knowledge of the main natural physical phenomena, fundamental of mathematics and thermo-physics.



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Geothermics Course 2025-2026

Course topics

INTRODUCTION TO GEOTHERMAL ENERGY Fundamentals of geology, the structure of the Earth, origin of geothermal resources, geothermal gradient and geothermal anomalies, the thermal properties of the ground, field methods to assess ground thermal properties. Geothermal exploration techniques.

FUNDAMENTALS OF THERMAL - HYDROGEOLOGY Introduction to groundwater and hydrodynamics in porous media. Water wells and wells design. Unsaturated zone and aquifers hydraulic and thermal properties. Heat propagation in groundwaters.

HIGH ENTHALPY GEOTHERMAL SYSTEM Geothermal reservoirs (water and vapour dominated geothermal systems, hot dry rock systems). Deep geothermal exploration techniques. Uses of high enthalpy geothermal systems. Estimation, sustainability and environmental impact. Economic highlights in the energy world market.

LOW ENTHALPY GEOTHERMAL SYSTEM Open-loop geothermal systems. Closed-loop geothermal systems. Thermal Response Test, Heat pumps and plants. Legal, technical and economic elements. Sustainability and assessment of resources. Environmental impact and implementation with particular focus on urban areas



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Geothermics Course 2025-2026

Course structure

- Lessons
- Numerical exercises on open and closed-loop systems
- Field trips:
 - 1) Low enthalpy geothermal plant in Padua (Humanistic Campus UNIPD)
 - 2) High enthalpy geothermal power plants in Larderello, Tuscany-Italy.
 - 3) Thermal Energy Storage Systems (*UNIPD Laboratories*).
 - 4) Euganean Geothermal Basin (Padova Province)
 - 5) Underground Food Storage Cells (Trento-Val di Non, Dolomites)

Main reading materials

Teachers notes. *These are the base for the exam.*

EXAM CONSISTS ON A PRESENTATION REGARDING AN ORIGINAL GEOTHERMAL IDEA AND DISCUSSION BASED ON COURSE PROGRAM

Suggested books:

- David Banks, An Introduction to Thermogeology: Ground Source Heating and Cooling, 2nd Edition. Wiley. ISBN: 978-0-470-67034-7
- Ronald DiPippo, Geothermal Power Plants (3rd Edition) Principles, Applications, Case Studies and Environmental Impact. Elsevier. ISBN: 978-0-08-098206-9

RENEWABLE ENERGIES

- THEY ARE RENEWED IN A SHORT TIME
- THEY ARE INEXHAUSTIBLE
- THEY ARE PRESENT THROUGHOUT THE PLANET EARTH
- THEY HAVE A REDUCED ENVIRONMENTAL IMPACT





RENEWABLE ENERGY SOURCES BECAUSE:

ENVIRONMENTAL REASONS (reduction of greenhouse effect and air pollution)

DIVERSIFICATION OF ENERGY SOURCES (improvement of security of supply)

REDUCTION OF THE RISK OF FLUCTUATION IN THE PRICES OF PETROLEUM PRODUCTS
(as an exhaustible reserve)

ECONOMIC AND EMPLOYMENT IMPACT (investments in a new industry with a high technological content)



SUSTAINABLE DEVELOPMENT (AS DEFINED BY THE UN COMMISSION ON ENVIRONMENT AND DEVELOPMENT)

"SUSTAINABLE DEVELOPMENT IS
DEVELOPMENT THAT MEETS THE NEEDS OF
THE PRESENT WITHOUT COMPROMISING THE
ABILITY OF FUTURE GENERATIONS TO MEET
THEIR OWN NEEDS."

The energy and environmental problem

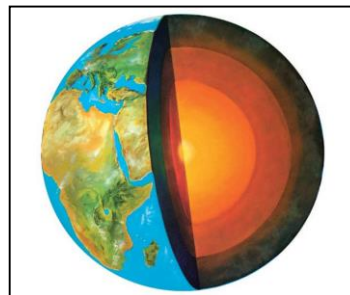


Exploitation of fossil resources. Problem of gas emissions into the atmosphere.

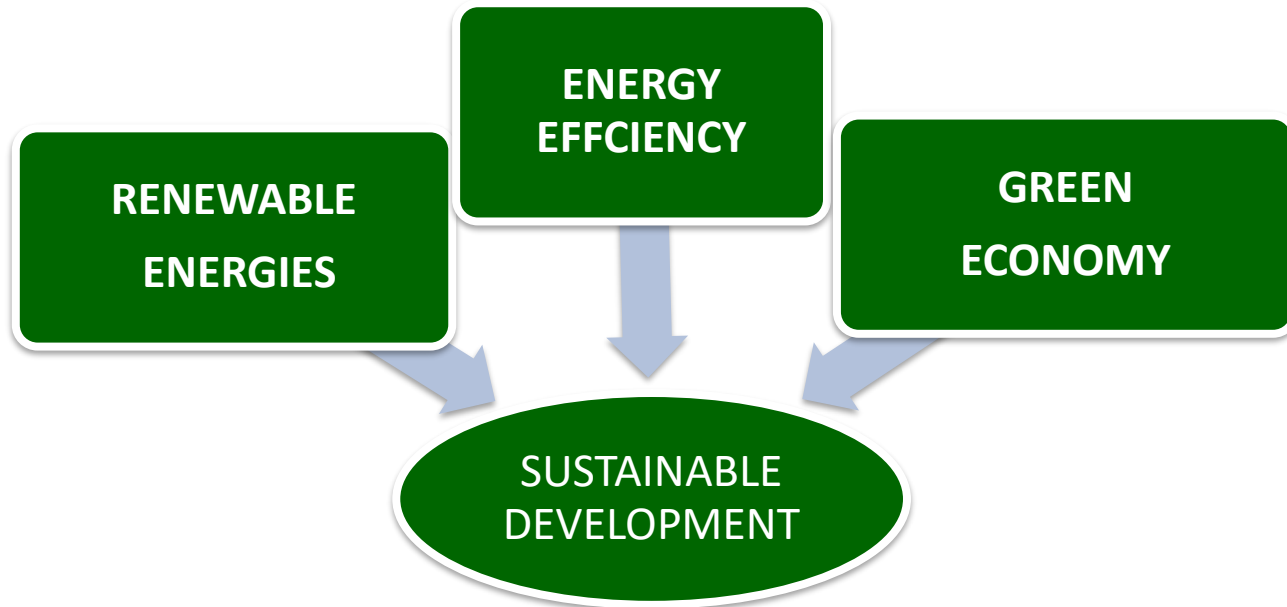


Need to reduce oil consumption through: -
Increased efficiency in existing systems Use of
"renewable" energy

GEO THERMICS



•SUSTAINABLE DEVELOPMENT



- Issues related to sustainable development are an unstoppable engine of renewal and social and economic development Technologies related to sustainable development tend to be increasingly pervasive Awareness at EU, national and regional level that these issues are inextricably linked to youth employment and economic development

GEO THERMAL ENERGY

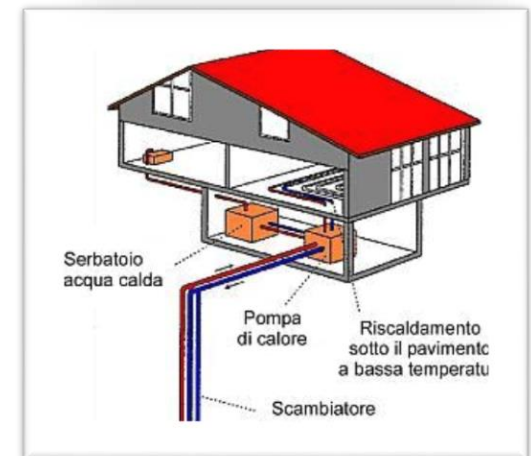
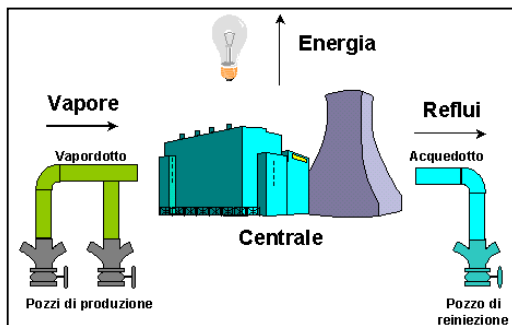
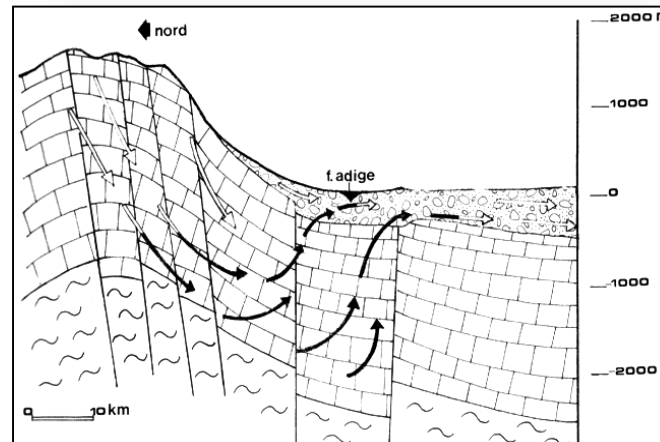
High temperature $> 90^{\circ}\text{C}$
(electricity production)



Average temperature $25-90^{\circ}\text{C}$
(thermal energy production)



Low temperature $< 25^{\circ}\text{C}$
(thermal energy production)



GEOHERMAL HEAT USE SYSTEMS

