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Rome 2004

Carbon Sequestration Leadership Forum

Rome 19-23 January 2004

CO₂ IN ITALY

G. Girardi

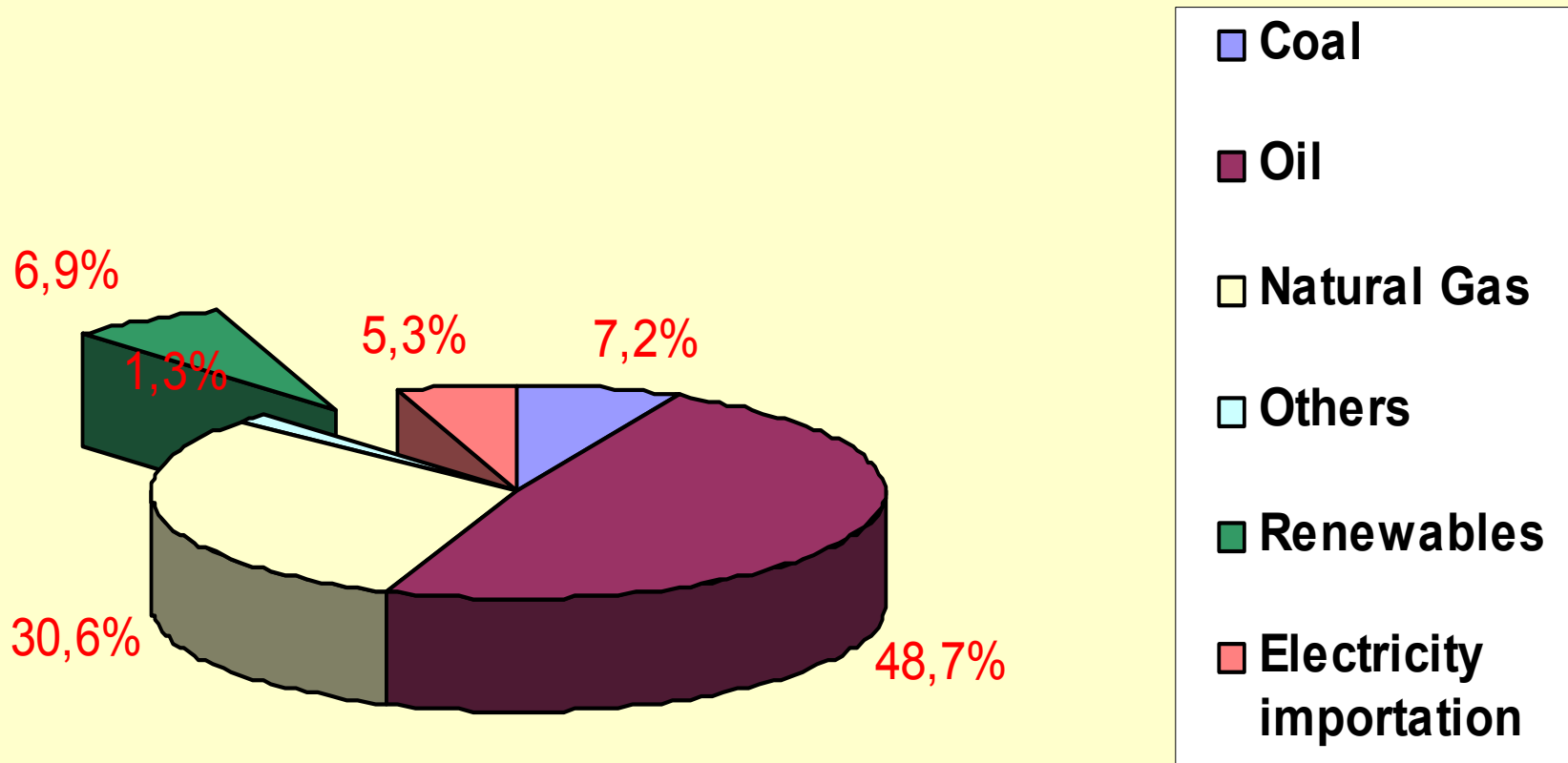
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Energy sources

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2001

Primary Energy Sources Contribution (%)

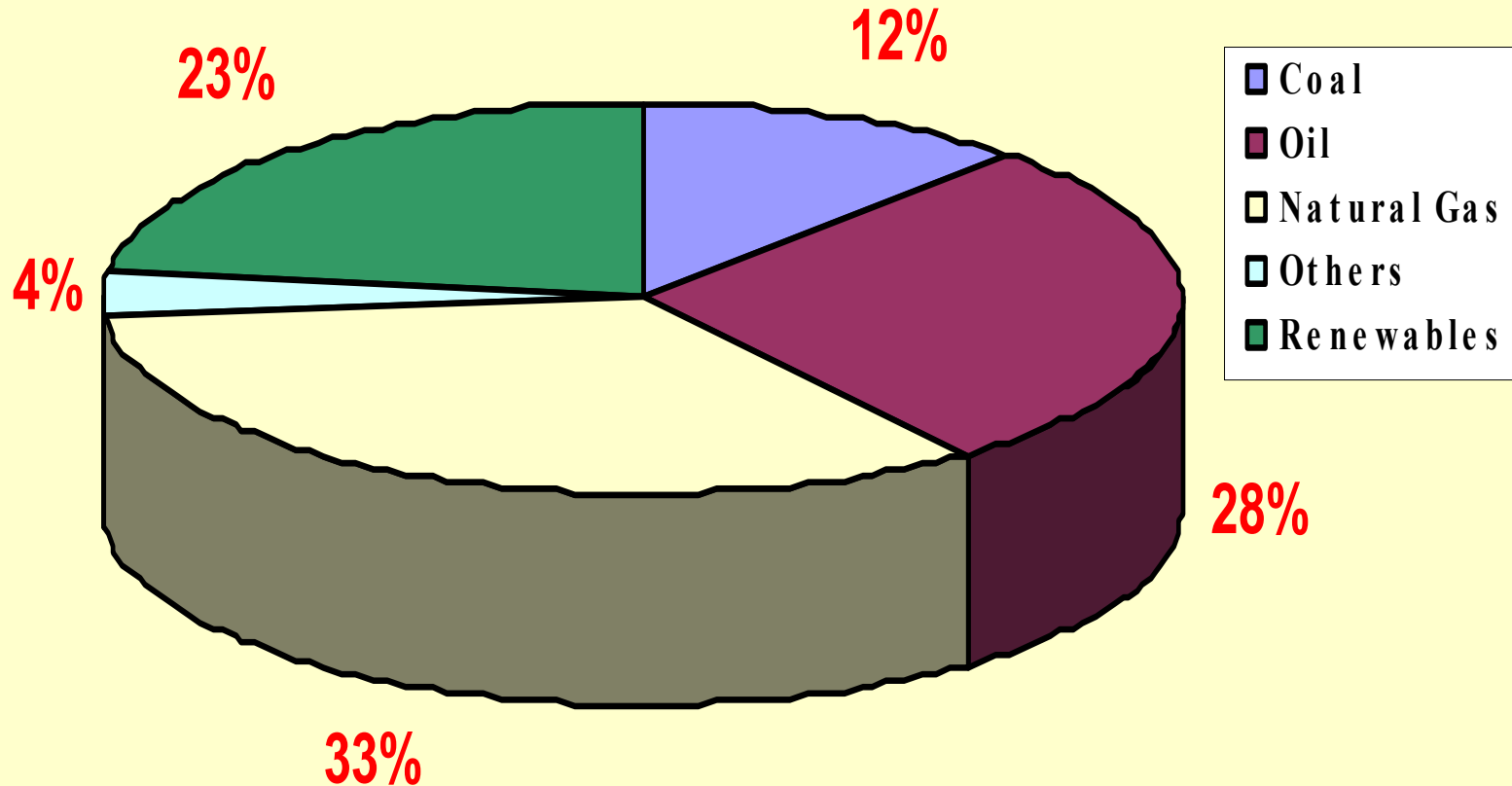
Total Energy Consumption = 186.6 MToe



Electricity production

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**Primary Energy Sources Contribution (%)
to 2001 Electricity Production (276 TWh)**

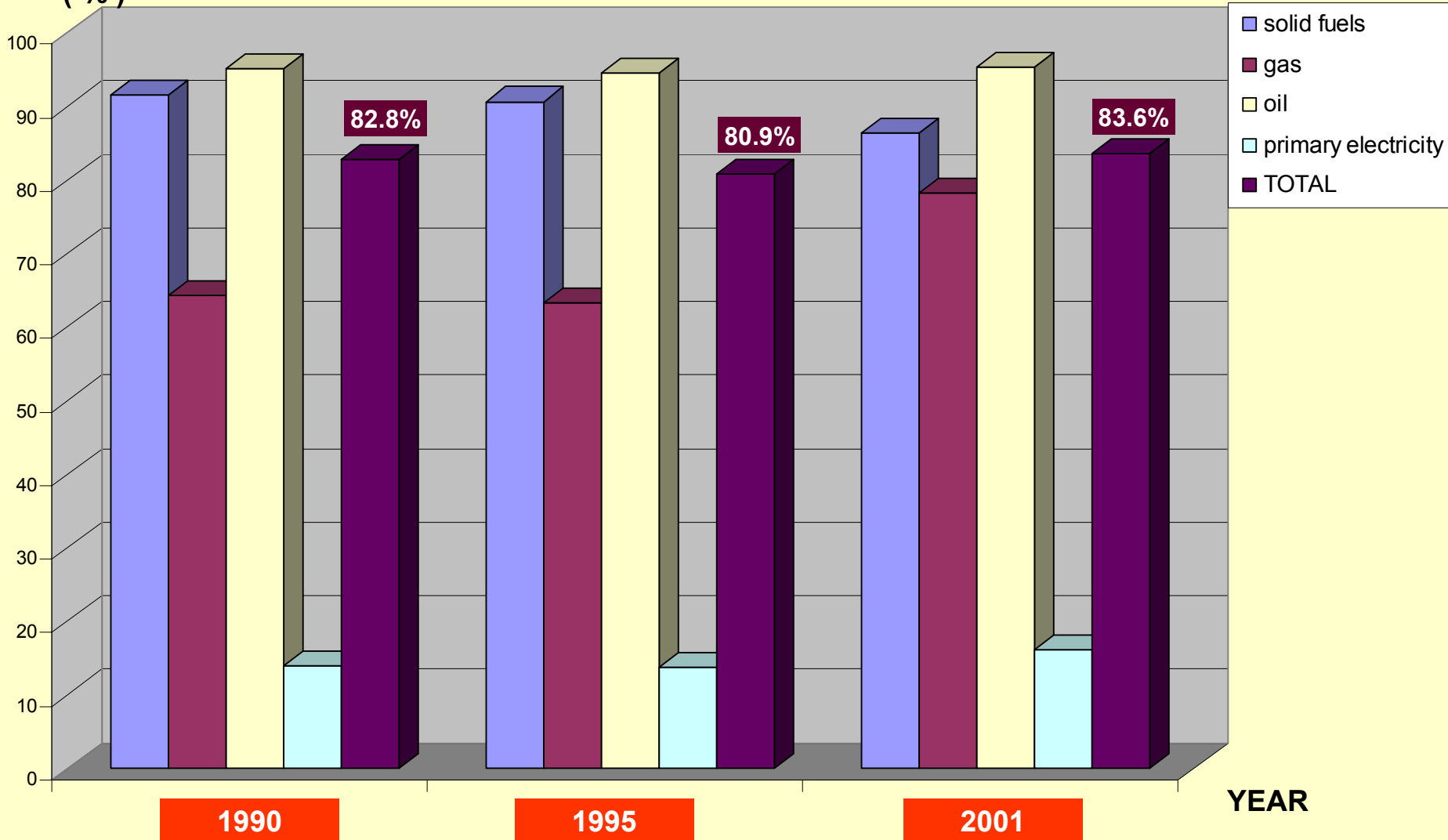


Italian Energy dependence

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net import / supply
(%)





Fuels & Electricity in Italy 2001

IMPORT

- Oil: imported for 95%
- Gas: imported for 80%

In Italy

ELECTRICITY PRODUCTION

- Oil and gas provide 61%
- Coal and Nuclear provide 70%

In Europe

This implies for Italy:

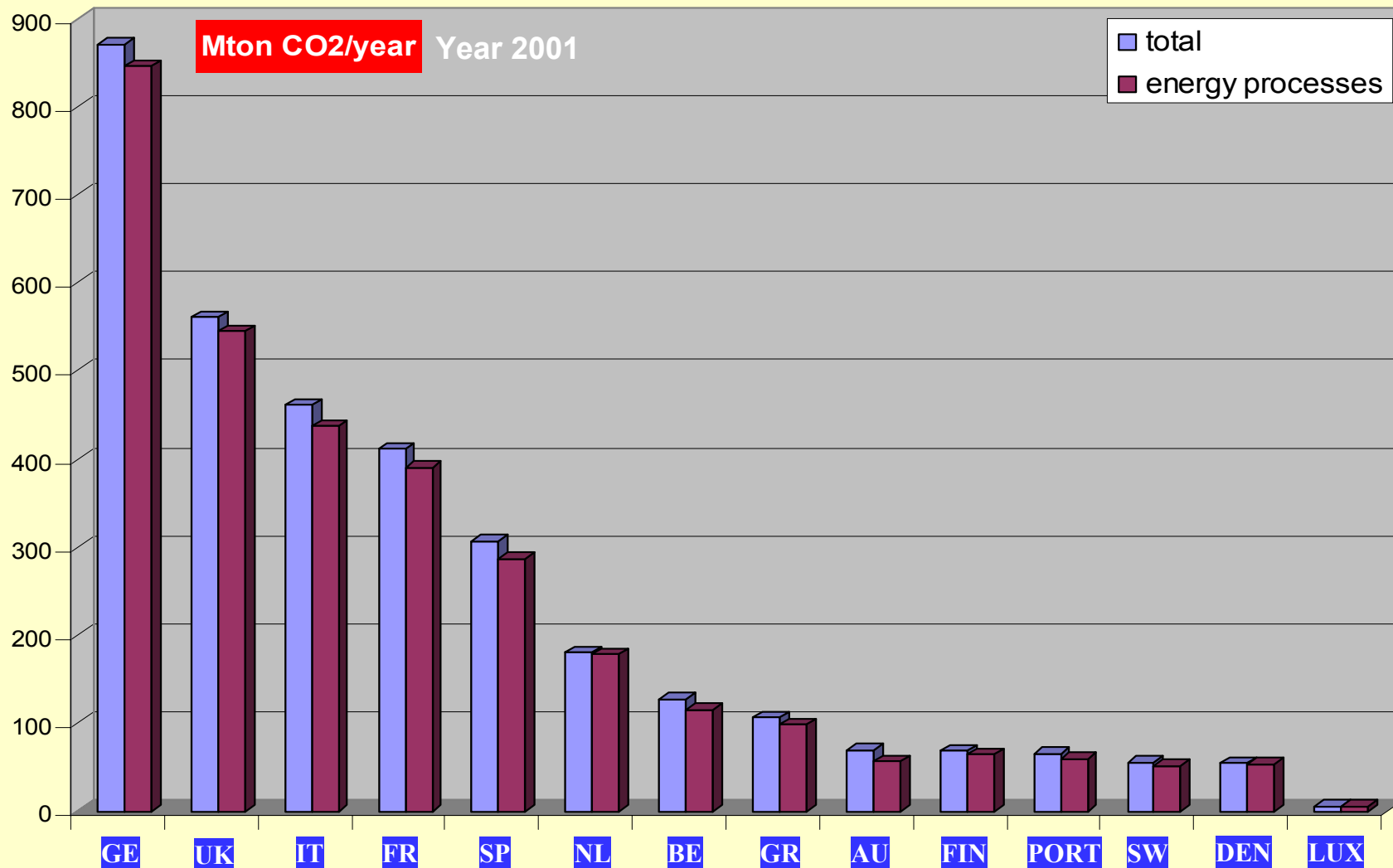
- Poor energy security
- High prices volatility (and level)
- Difficulty to reduce the GHG emission (Kyoto Protocol)



CO₂ emissions in european Countries

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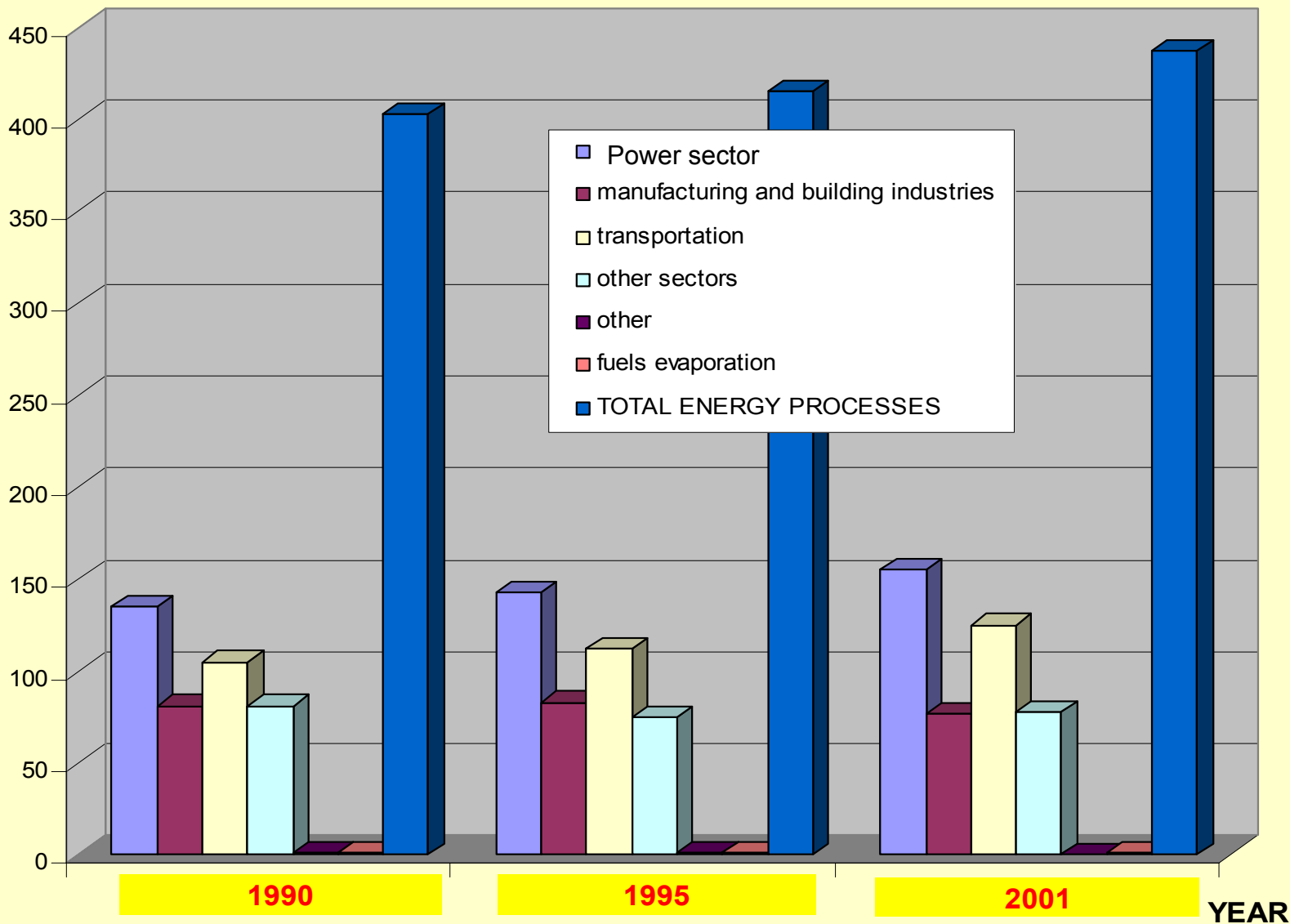




CO₂ emissions in Italy

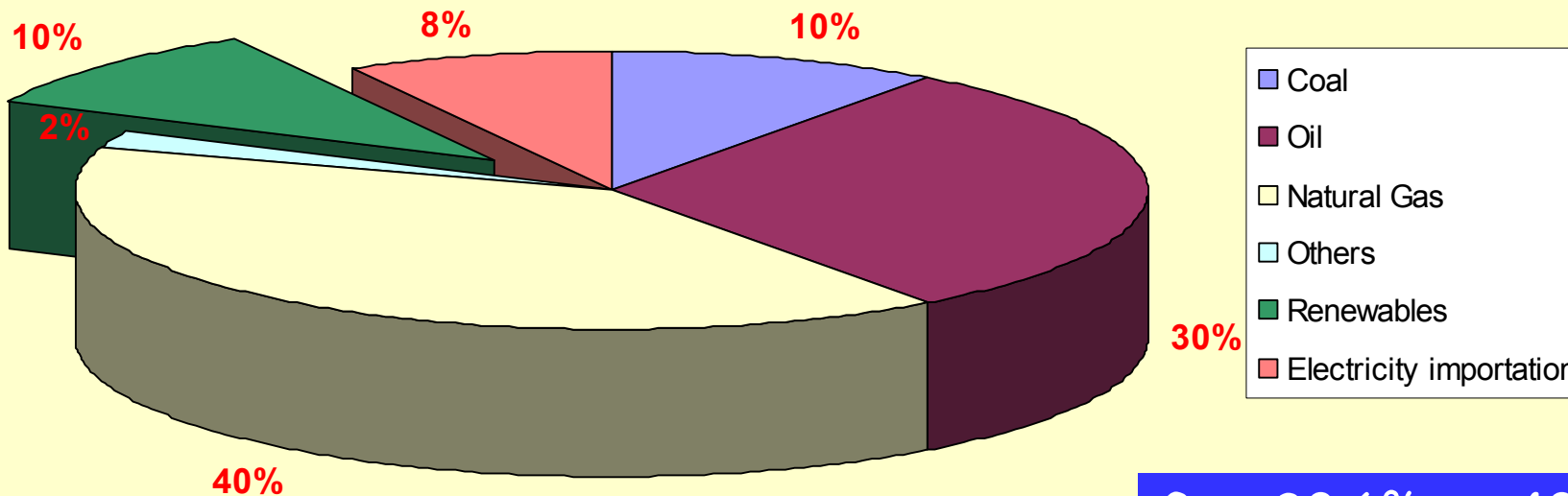
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Energy sources forecast (2010)



Gas: 30.6% → 40%
Coal: 7.2% → 10%
Oil: 48% → 30%

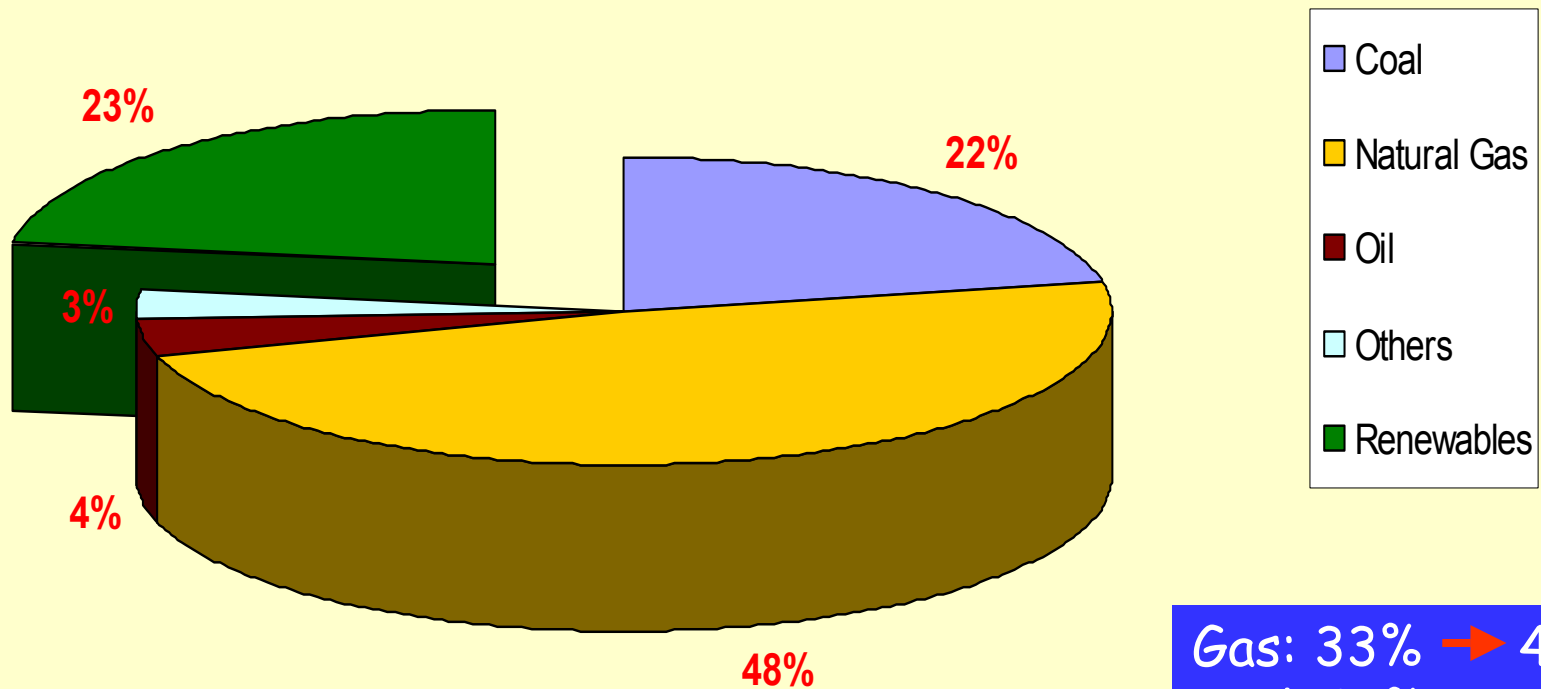
2010 Forecast
Energy Sources Contribution (%)
Total Energy Consumption = 200 MToe



Electricity prod. forecast (2010)

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**Primary Energy Sources Contribution (%)
to 2010 national Electricity Production (330 TWh)**



Greenhouse gas emissions in Italy

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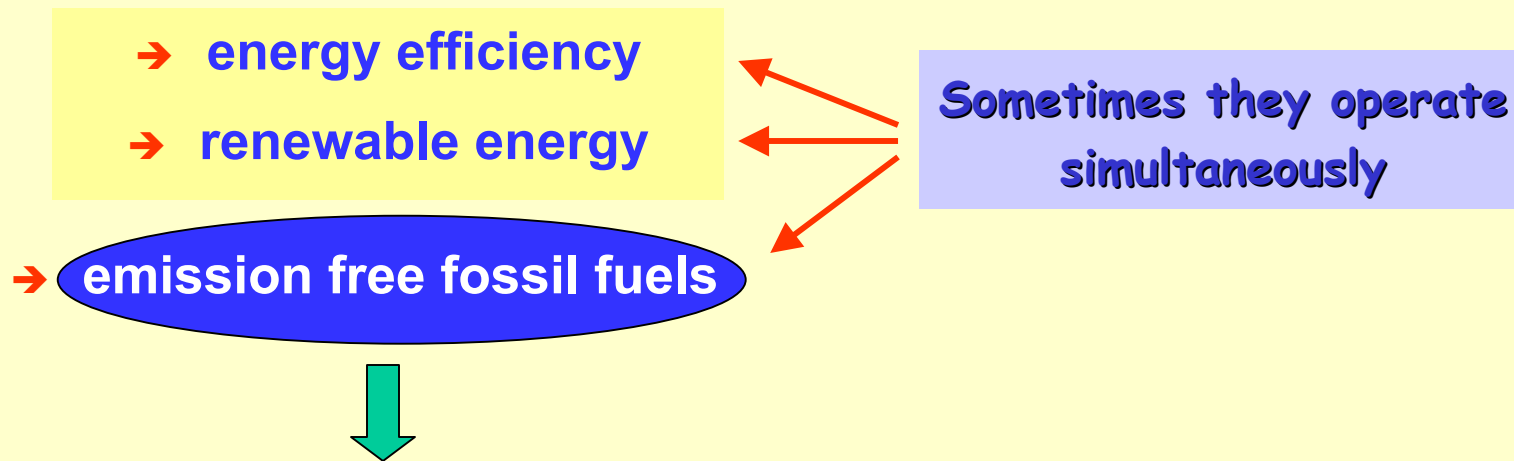
- Italy is committed to reducing its total GHG emissions by 6.5% in 2008-2012 compared to 1990 levels
 - 93 million tonnes by 2010 from the projected level in 2010 without any measures
- Energy-related CO₂ emissions have been growing gradually and were 6.5% above the 1990 level in 2001 reaching 437 Mt of CO₂
 - Power sector: 155 Mt CO₂ (1/3 total)
- Italian Carbon intensity: 0.35 kg CO₂/\$GDP in 2000 (IEA av. 0.43, EU av. 0.37)



- Policy measures (voluntary agreements, carbon tax, regulations, international agreements, ...)
- R&D initiatives



Three Horses of the "Troika"



Carbon Capture and Storage (CCS),
i.e. Carbon Sequestration,
Is a crucial issue in energy policy:
it is the third horse of the troika



Some ideas for energy plants

- plants based on new cycles and advanced technologies in gas turbines, boilers, gasifiers (medium - long term)
 - Gasification of coal (and biomass) & CCS
 - High efficiency / ultra low - zero emissions combustion
 - Advanced combustion; High temperature high dilution (flameless/mild) combustion
 - New fuels and energy carriers
 - syngas from gasification of different primary products
 - Hydrogen, H₂ rich gas mixtures
 - Plant Integration
- decentralised polygeneration systems (short - medium term)
 - Cogeneration and poly-generation
 - Hybrid systems with gas turbine and fuel cells
 - High flexibility in plant design and fuels burning



Poly / Decentralized Generation

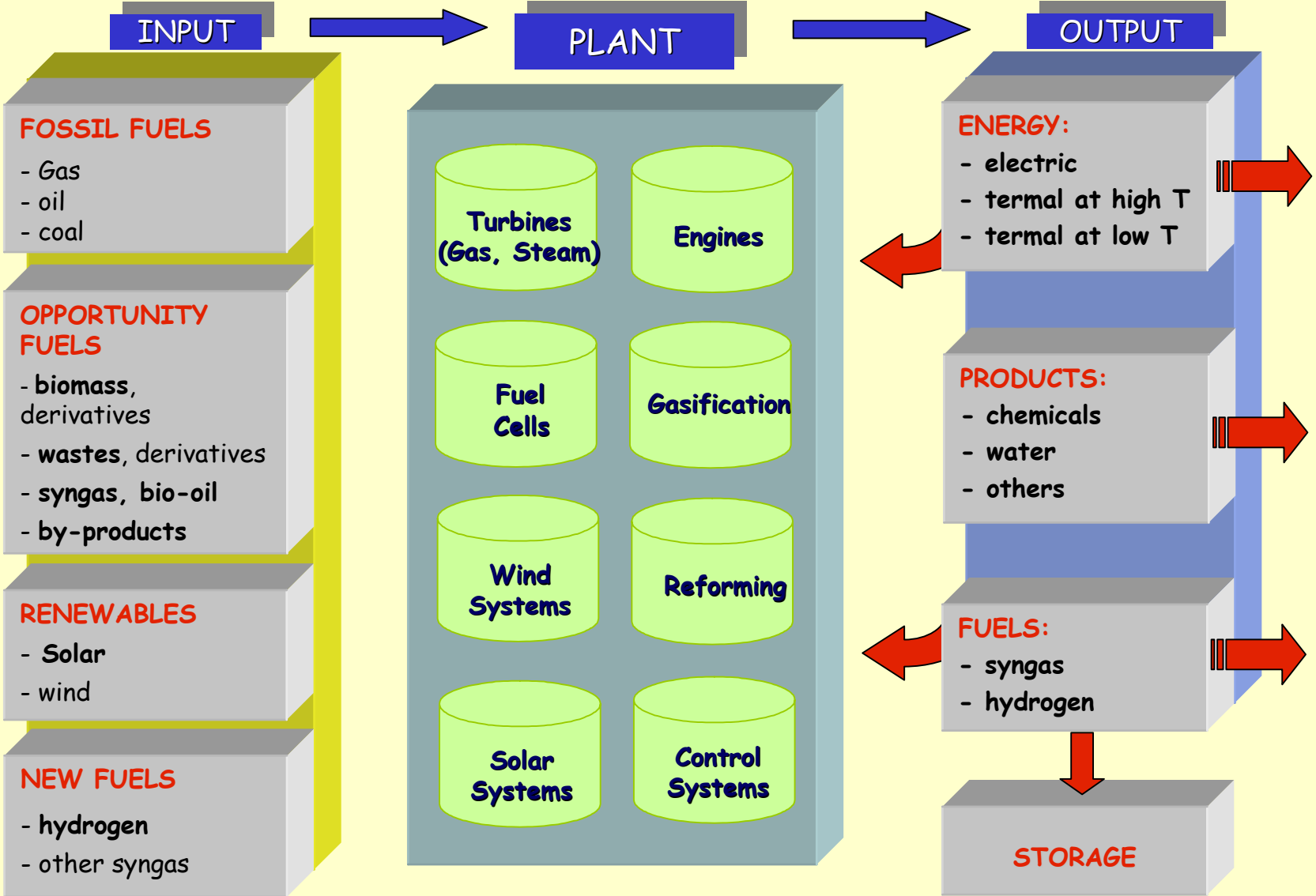
New energy systems for combined generation of:

(1) electricity, (2) heat and cool, (3) other products

- by designing plants integrated with the social and productive context of the territory
- which allow the diversification and integration of primary resources, and the increasing of the use of renewable sources, new fuels and energy carriers
- Which produce other products too - as chemicals, energy carriers, ... - and services - as energy recovery and heat and cool production by process refuses and industrial and civil wastes



Poly / Decentralized Generation





Energy RTD in Italy

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- **International and National Programmes**
- **Measures for promoting Research and Innovation:**
 - basic research
 - industrial and pre-competitive research
 - demonstration and dissemination

National projects and programmes supported by:

- National Government: short to long term
- Ministry of Productive Activities/Environment: short to medium term
- Ministry of Research: short to long term
- Regional Governments: short term



International Projects

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- ❖ Weiburn
- ❖ CCP
- European FP5 & FP6
 - CASTOR (IP) and CO₂GEONET (NoE): ongoing

→ Strong interest in FP6: Industry, R&D organizations, Universities

→ Strong interest in the next call on CO₂ capture and Storage:

- ▶ Pre combustion technologies (mainly for coal gasification), integrated in advanced high temperature gas turbine cycles
- ▶ Post combustion technologies
- ▶ Oxy firing: CO₂ recycling, H₂-O₂ combustion with steam recycling
- ▶ Geological storage
- ▶ Mineral sequestration (CaO-CaCO₃, silicates, carbonates, ..)



CO₂ Capture Project (CCP)

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main activities :

- screening and assessment of existing and new technologies
 - Capture (pre combustion, post combustion, oxy firing)
 - Storage, Monitoring and Verification (SMV) of geological storage
 - Comparative economics of capture options
- next 4-year phase of CCP (CCP²)



CO₂ CS R&D national programmes

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Research National Programme (PNR):

- Duration: 3 years (2004-2006)
- Different priority themes
- Participants: Industry, University, R&D Centers

Fund for R&D on the Electricity System:

- Collect of electricity bills (<0.03 c€/kWh)
- Scientific & Technological collaboration between Universities and companies
- 1st 3-years programme is finishing
- 2nd 3-years programme is now launching



priority theme: **NEW TECHNOLOGIES FOR ENERGY
GENERATION AND MANAGEMENT**

Two areas

- **Hydrogen carrier: 50 M EURO public funding**
- **Fuel cells: 37 M EURO public funding**



Hydrogen Carrier & Fuel Cells

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Hydrogen Carrier:

- Development of technologies, components and new systems for **hydrogen production** and for **H₂/CO₂ separation**
- Development of materials and new systems for hydrogen storage
- Study of **CO₂ capture and sequestration**, and development of related technologies
- Development of technologies, components and systems for hydrogen utilisation in: transport and **distributed electricity generation**

Fuel Cells:

- Development of materials, components and advanced assembly of **different fuel cells**
- Development and testing of **systems utilising fuel cells** for transport, electricity generation, and for portable systems



PNR main project portfolio

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- Development of coal syngas treatment technologies for hydrogen production and CO_2 C+S
- Hydro/conventional gasification of coal for hydrogen and power generation - high efficiency power generation cycle, high temperature gas turbine based, firing H_2/O_2 with steam recirculation - with CO_2 C+S
- New technologies for hydrogen production from coal for automotive and cogeneration
- Hydrogen for gas turbine power generation, including CO_2 C+S
- CO_2 sequestration in geothermal reservoirs
- Hybrid systems for decentralised electricity and heat production: fuel cell (MCFC) + mini gas turbine
- CO_2 geological sequestration



→ Power Plant Configurations

- ▶ Fuel de-carbonisation
- ▶ Enriched air combustion

→ CO₂ Separation & Capture

- ▶ Investigation on solvents for flue gas treatment
- ▶ Assessment on membranes
- ▶ Terrestrial eco-systems
- ▶ Biological fixation



CSLF Issues

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- Hydrogen production from fossil fuels and RES is a priority for Italy long term energy R&D policy
- CO₂ C+S is a complementary subject to hydrogen
- Italian industry has a significant Oil&Gas sector focused on refinery and hydrocarbons processing R&D
- High interest in R&D and Demonstration
 - ▶ CO₂ storage
 - ▶ Component and processes technologies (CO₂ capture)
 - ▶ System integration



Main options:

- **Underground**

- Deep aquifers
- Oil and gas fields (depleted reservoirs, EOR)
- Enhanced Coal Bed Methane

- **Mineral sequestration**

- Process treatment: Calcium oxide - Calcium carbonate cycle, integrated in the gasification and syngas cleaning
- Storage: silicates, carbonates, ..



CO₂ underground storage

- The number of demonstration projects realized in the world is so large to demonstrate the feasibility of geological sequestration of CO₂.
- In Italy, from a general point of view, the geological storage of Carbon Dioxide is feasible.

Nevertheless it is of paramount importance now to indicate:

- where,
- how much,
and consequently
- for how many time

we could store CO₂ without risks for the population and for the environment.

- Lastly the captured CO₂, produced by present energy power plants, which will use coal, can be transported to the selected sites for the storage, using a large-network of pipelines.



"CONFITANET" : RESEARCH PROGRAM FOR GEOLOGICAL SEQUESTRATION IN ITALY

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The National program for Carbon Dioxide sequestration in geologic formations was defined by a research group constituted by the main Italian Industries, Research Organizations and Universities.

It's a three years project, proposed to be financed in the National Program for Research; its amount is 15 millions Euro (12 M of U.S. \$).



Aims of CONFITANET

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- **Quantify existing potential spaces** in the ground and consequently the national potential capacity to storage the CO_2 during the time (estimated national amount of CO_2 = 60-100 million tons/year);
- **Mathematical Modelling** to support the effective evaluation of the spaces and the risk analysis (Geochemical and physics; fluid and dynamics; geomechanical);
- **Impact analysis** (Negative: Man induced micro-seismicity; Positive: rebound and reduction of subsidence);
- State of the art about the **natural emissions from the ground** (CO_2 soil content) to define the state "ex-ante";
- Research on the **interaction processes among water-rocks-gas** in three natural analogues (Mount Amiata; Volcanic Alban District; Bradanic Fore-deep);



Aims of CONFITANET

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- **Unknown Active faults and volcanic risk analysis**, in order to define the risk of leakage;
- **New sensors and new technologies to use for monitoring** at low cost and of easier use (Geochemical sensors; Remote Sensing Monitoring or Radar Interferometry);
- **Technical-economic feasibility analysis** to stabilize the CO_2 in more stable compost using **magnesium chloride**;
- **To find new strategy of communications** to transfer to the population some geological concept and to determine their acceptance;
- **New legislation** related to the CO_2 geological storage;
- **The research of a site where realize a demonstration project** (if strictly necessary).



Where in Italy

- In Italy probably it is possible to storage CO_2 in depleted Oil and Gas reservoirs, in geothermal fields and in deep saline aquifers, either on-shore or offshore
- The saline aquifers are particularly well distributed in the Padanian back-arc basin and in the Adriatic Basins
 - These geological structure are extended from Padania Valley to the Sicily and seems to offer the presence also of different natural analogues, depleted oil and gas reservoirs useful for the project
- EOR could be studied: proposal regarding Adriatic sea
- ECBM too could be studied: proposal regarding coal bed in Sardinia



Areas where the best geological formations are localized in Italy (CONFITANET data)

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Two ideas for proposal: EOR, ECBM

"SIBILLA": EOR demonstration site



- to capture 550 tonnes/day CO₂ (83 bar) peak, vented by the Falconara gassifier, sequestering 1.5 Mt CO₂ in 10 years
- to recovery of approx. 6 million barrels of crude oil in 10 years.

Enhanced Coal Bed Methane in Sardinia "Sulcis" area

The SULCIS coal basin exhibits a general deepening of the productive strata reaching 800 m injection depth.

main goals of the Project:

- to exploit an ECBM technique throughout the *Sulcis Coal Province*
- to accomplish a significant CO₂ geological sequestration (10⁶ tonns storage foreseen), in the frame of the ECBM cycle.

Main expected results:

- feasibility study for the ECBM technique development for the coal bed strata deeper than 800 m to inject CO₂ at supercritical conditions
- the first test wells drilling (CO₂ injection and CH₄ production).



Main Technical Actors

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- ❖ ENEL
- ❖ ENI
- ❖ ANSALDO Energia
- ❖ ANSALDO Ricerche
- ❖ ANSALDO Fuel Cells
- ❖ ENEA
- ❖ CESI
- ❖ SOTACARBO
- ❖ INGV
- ❖ CRS4