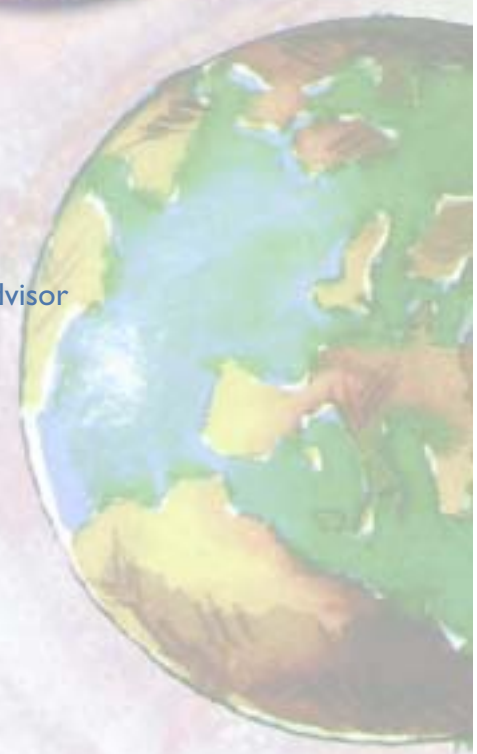
Executive Summary
of the Report Energy and the Environment 2004

ENEA - Agency for Sustainable Development - Advisor



The Report on Energy and the Environment 2004, prepared by ENEA, is the result of a yearly in-depth analysis of the data on the Italian energy situation, with due references to the international framework, and in this context constitutes a valid and unique tool for reference.

As in the previous years' reports, this Report presents the evolution of the national energy situation with reference to the demand for and supply of energy, and those environmental issues related to the energy sector, taking the undertakings made at government level into account.

The document also presents regional and local energy and environmental strategies, and provides an overview of developments in research and technological innovation in the energy field in our country.

The 2004 report is composed of two parts:

- ***The analysis**, which outlines the evolution of the Italian energy-environment situation over the last year, in the context of the global macroeconomic and energy framework;*

- ***The data**, containing the energy, economic, environmental and statistical data at international, national and regional level;*

and this Compendium, which presents a summary of the most significant data contained in the Report.

The Report Energy and the Environment 2004 was prepared with the partial contribution of the 2000-2006 Community Support Framework, Objective 1, PON-ATAS-FESR, Energy Operational Programme, Action 1.

ENEA-PON-FESR-2004-053

The international framework

Economy

The World economic activity has shown marked growth (+3.9%) since the second half of 2003, coinciding with the recovery in investment in information technology in the United States. The monetary policies and expansive budgetary policies adopted by the governments of the major countries contributed to this growth. Significant recoveries in share prices in all markets were recorded in this phase.

The accelerating recovery in the United States and the strong growth displayed by the Chinese economy facilitated the growth of international trade (+4.5%).

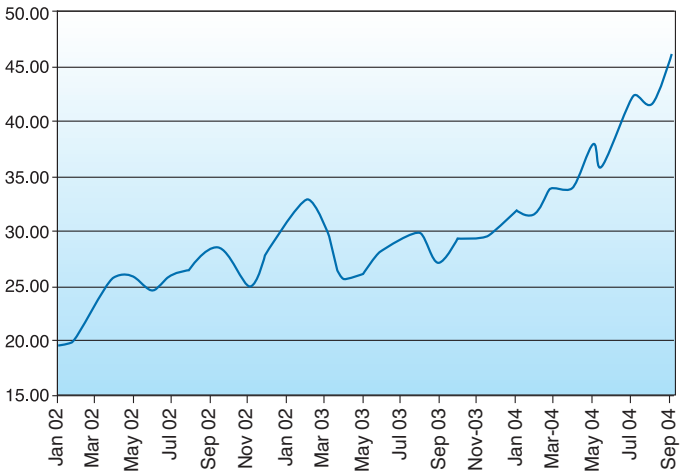
The trade increase favoured mainly the Asian countries. With a 12% growth in exports, these countries maintained their competitiveness and contained the strengthening of their currencies by accumulating monetary reserves in dollars. In contrast, the strengthening euro influenced the competitiveness of the euro zone, whose exports stagnated.

In 2003 the price of crude oil, as an average of Dubai, Brent and WTI, touched 30 dollars a barrel, an increase of about 16% over 2002 (figure 1).

The price of crude oil was affected by the crisis in Iraq and by the recovery in world production activity, as well as by the decision of the oil-producing countries to maintain high oil prices to compensate for the loss of purchasing power caused by the weakness of the dollar. In early 2004, the growth in the world economy, the speculative pressures, the worsening of the political situation in the Middle East, and the decision by OPEC countries to cut production, caused a further rise in price, which reached 38 dollars a barrel at the end of May. Despite the increase in production by OPEC at the beginning of September 2004, prices rose to over 50 dollars a barrel by October.

This expansion of the economic cycle is burdened by some unbalanced elements that could attenuate its intensity. Firstly, the widening gap with the United States has amplified the downward pressures on the dollar exchange rate. This effect reduced the competitiveness of the euro zone countries, and was at the origin of an economic recovery not uniform across all geographical areas. Secondly, the high rate of development of the Chinese economy sustained the growth in China's demand for energy products and raw materials.

Figure 1 - Oil price* (US$/barrel)



* Average of Dubai, Brent and WTI.
Source: ENEA data processing of DOE and IEA data

At the same time, the rigidity of the supply, and the depreciation of the dollar have caused prices to rise sharply, amplified, in the case of oil, by the uncertainties related to the geopolitical situation in the Middle East.

The economic recovery coincides with the recovering demand in the **United States** favoured by the devaluation of the dollar, an expansive monetary policy and an increase in the federal deficit. Particularly low interest rates have triggered a radical restructuring process that exploits new information and communication technologies to achieve gains in efficiency and to increase the flexibility of production processes. The significant increase in productivity has increased profits, and allowed investments to recover, particularly in high technology capital goods.

The budget policy has also provided a strong stimulus to demand: the growth in military spending and homeland security costs, and the effects of the tax cuts, have widened the budget shortfall which has increased consumer spending in various ways.

The increasing disparity between the rate of economic growth in the United States and the rate of growth in its main trading partners has further worsened the United States foreign accounts. The current account balance was particularly affected, and in 2003 the deficit reached 5% of the GDP: the highest in over 20 years.

The trade deficit was compensated by an inflow of capital from abroad: investments in United States bonds by the Chinese authorities and other Asian countries were particularly strong, with the latter accumulating reserves to counterbalance the strength of their currencies against the dollar.

In 2003 **the Japanise economy** grew at rhythms higher than expected (figure 2). The gross domestic product grew by 2.5%, thanks to the incentives provided by exports to other Asian countries and by private investments. After an extended period of stagnation, the capital accumulation resumed, favoured by the recovery in business profitability, particularly for the large companies in the manufacturing sector. The result, partly attributable to the cyclical improvement, is also fruit of the financial and organisational restructuring of the industrial system undertaken since the mid-nineties to improve productivity.

In the euro zone, the gross domestic product increased by 0.4% on average in 2003, lower than the 0.9% recorded in 2002 and less than the 2002 forecast (1.1%). Growth was particularly low in Germany, Italy and France, and higher than average in Spain. The weakness in national demand, and the unfavourable trend in foreign trade contributed to this slowdown.

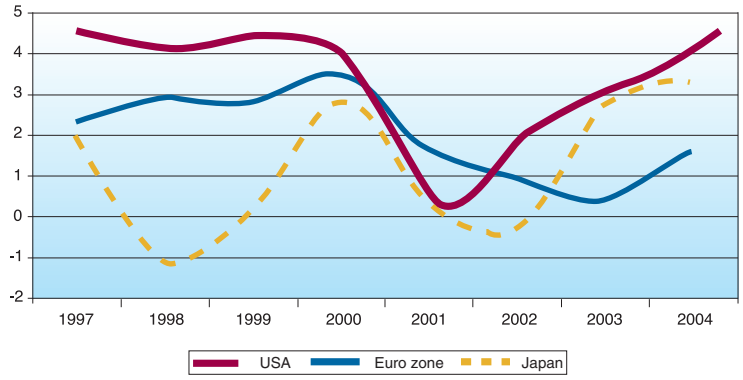
The strength of the euro reduced competitiveness in international markets, causing exports to stagnate, while imports grew, and the contribution of foreign trade to GDP creation was negative in all the major economies of the area.

Consumer spending increased slightly, according to the employment rate in the different countries.

Despite the fact that financing conditions in the area continued to be favourable, levels of investment fell for the third consecutive year, slowed down by the low degree of production capacity and the somewhat gloomy expectations of the business community.

Given the high deficits in the major countries of the area, in 2003 budget policies were again unable to counter the cyclical weakness with expansive policies. Net government deficits grew to 2.7% of GDP during the year, up from the 2.3% of the previous years, and in many countries the balance results were significantly worse than the objectives set in their stabi-

Figure 2 - Real GDP – Trend variations (%)



Source: ENEA data processing of IMF data

lity plans. The main reason for not reaching the objectives was lower than expected growth in GDP.

The emerging economies recorded growth rates of over 6% in 2003, compared to 4.6% in the preceding year, with great disparities between the different areas. The highest acceleration in production activities was recorded in China, India, the former Soviet Union countries and the major African countries.

The exceptional growth in the Chinese economy (9.1% in 2003) was stimulated by strong growth in investments. China now plays a major role in Asian trade: Chinese GDP represents over 45% of the combined GDP of the region (13% of world GDP), and imports to China (14% of exports from emerging countries in the region) help the development of the other Asian economies, while the growing interdependence of the economies of the area also promotes flows in the opposite direction: Chinese exports now account for about 16% of the imports of the other countries in the area. Chinese products have also penetrated the US market, where China is its second-largest trading partner after Canada.

The growth in world GDP and the expansion in international trade expected in 2003-2004 are based on the fiscal expansion of the United States, which sustained the international economic recovery. However, this situation cannot last much longer, since financing the United States deficit will subtract resources from private investments in both the United States and abroad. Higher long-term interest rates in the private capital market, together with the fear of further shocks due to more expensive energy products and other raw materials, are generating expectations that the monetary authorities will raise base rates. This could all lead to an increase in prices that would slow recovery and increase personal and business debt, already high in some economies (United Kingdom, Australia, United States, Ireland, New Zealand and the newly-industrialised Asian countries).
The dual imbalance in the finances of the United States, that is, the budget deficit and the current account deficit, is sustainable at present only because of the capacity of Asian countries to accumulate monetary reserves in dollars and Treasury Bonds. To tackle this situation the United States government, in a plan presented in February 2004, undertook to reduce the federal budget deficit to 1.6% by 2009, by drastically limiting discretional spending, including defence spending.

These measures could contain the dynamics of US domestic demand in a framework of stable exchange and financial markets, although the hard-to-quantify risk deriving from geopolitical instability still remains, as do the inflationary pressures triggered in the short term by the rigidity in supply of energy products.

Energy

The world consumption of primary energy grew by 2.9% in 2003, according to British Petroleum,. This growth appears particularly sustained in Asia and the Pacific (+6.3%), led by the Chinese economy, and is also strong in Africa (+4.4%) and the former Soviet Union countries (+3%); the areas with lower growth are North America (+0.2%) and Western Europe (+1.8%) (tables 1 and 2).

In 2003, oil accounted for 37.3% of world consumption, coal for 26.5% and natural gas for almost 24%. The remaining 12.2% was split equally between hydroelectric power and nuclear power. In relative terms, coal's share of the primary supply in 2003 continued to grow, while the shares of the other considered sources decreased. This is the result of a 6.9% growth in global coal consumption in the period 2002-2003, a rate which is more than twice the growth in total energy consumption. Despite a slight drop in its share of primary energy consumption (from 38% in 2002 to 37.3% in 2003), oil remains the most used energy source at global level. In 2003 the world demand for oil grew by 2.1% over the previous year.

Oil satisfies 40% of the energy demand of North America: consumption grew after the economic recovery, which was hardly affected by the price increase. Demand grew particularly in Canada, while growth was lower in the United States and Mexico. Oil consumption in Central and South America decreased by 1.2% overall, with a considerable drop in Venezuela (-11%), due to political instability and a halt in oil production; oil consumption for electric power generation also fell in Brazil and Chile, because of the deve-

Table 1 - Primary energy consumption by geographical area (Mtoe)

	2002	2003	Variations 2003/2002 (%)	Share 2003 (%)
North America	2721.0	2727.3	0.2	28.0
Central and Southern America	454.5	4465.5	2.4	4.8
Western Europe*	1793.0	1824.4	1.8	18.7
Former USSR, EiT **, Turkey	1057,5	1089.0	3.0	11.2
Middle East	416.8	426.8	2.4	4.4
Africa	286.9	299.6	4.4	3.1
Asia and Pacific	2734.8	2908.4	6.3	29.9
World	9464.5	9741.1	2.9	100.0
of which: EU (15)	1471.5	1498.1	1.8	15.4
OECD	5356.2	5397.9	0.8	55.4
Former USSR	958. 0	987.0	3.0	10.1

Source: ENEA data processing of BP data

* Including the new ten EU member countries
** Economies in Transition: Bulgaria, Romania

Table 2 - Primary energy: consumption by source and geographical area. 2003 (%)

	SHARE PER SOURCE (%)					
	Oil	Natural gas	Coal	Nuclear	Hydro-electric	Total
North America	40.1	25.2	22.5	7.4	4.9	**100.0**
Central and Southern America	46.5	21.2	3.8	1.0	27.5	**100.0**
Western Europe*	39.9	23.2	17.9	12.5	6.6	**100.0**
Former USSR, EiT**, Turkey	19.8	50.8	19.3	5.3	4.9	**100.0**
Middle East	50.4	47.0	2.0	–	0.7	**100.0**
Africa	40.2	20.1	32.4	1.0	6.3	**100.0**
Asia and Pacific	36.1	10.7	44.9	3.6	4.7	**100.0**
World	**37.3**	**23.9**	**26.5**	**6.1**	**6.1**	**100.0**
of which: EU (15)	37.3	23.9	26.5	6.1	6.1	**100.0**
OECD	42.7	24.3	14.9	13.6	4.6	**100.0**
Former USSR	41.2	22.9	21.4	9.4	5.2	**100.0**
	VARIATIONS 2003/2002 (%)					
North America	2.1	-3.5	2.5	-1.9	-1.7	**0.2**
Central and Southern America	-1.2	8.7	1.1	6.8	4.2	**2.4**
Western Europe*	0.8	4.6	3.5	1.0	-4.7	**1.8**
Former USSR, EiT**, Turkey	1.7	3.0	6.0	3.2	-2.9	**3.0**
Middle East	0.8	4.0	2.4	–	15.4	**2.4**
Africa	2.2	8.3	5.8	3.4	0.0	**4.4**
Asia and Pacific	4.0	5.6	10.3	-11.0	5.1	**6.3**
World	**2.1**	**2.0**	**6.9**	**-2.0**	**0.4**	**2.9**
of which: EU (15)	0.5	4.3	3.7	0.6	-1.4	**1.8**
OECD	1.6	0.1	2.7	-3.5	-2.2	**0.8**
Former USSR	1.6	2.2	7.3	5.6	-1.0	**3.0**

Source: ENEA data processing of BP data

* Including the new ten EU member countries
** Economies in Transition: Bulgaria, Romania

lopment of large hydroelectric facilities in the former and the construction of natural gas power stations in the latter.

Oil consumption in Western Europe increased by just 0.8%; however, among oil products there was increasing use of diesel fuel and a corresponding fall in petrol consumption.

Oil accounted for 40.2% of the overall energy requirements of African countries, an increase of 2.2% over 2001. This growth was due to the transport sector, while consumption remained essentially low in industry and in electric power generation, due to the availability of other energy sources (natural gas in Algeria and Egypt, coal and nuclear energy in South Africa), and to the use of traditional fuels in households.

World oil production increased by 3.8% compared to 2002. The increase mainly concerned the OPEC countries, which augmented the production by 91.2 Mt (+6.6%), and the countries of the former Soviet Union (+10.2%), while there was a slight drop in non-OPEC countries (-0.2%). The outbreak of war in Iraq led to a drastic reduction in Iraqi output (-33.8%), partially compensated for by increased production in Saudi Arabia, Kuwait, Iran and the United Arab Emirates. Oil production in a number of areas in Africa (+5.5%) is assuming greater importance in satisfying world demand, where traditional producers such as Algeria, Libya and Nigeria are being joined by new ones like Angola, the Republic of Congo, Equatorial Guinea, Sudan and Chad.

Coal satisfied 26.5% of the global energy requirement, making it the second energy source at world level. While it covers less than 4% of the regional energy demand in the Middle East and in Central and South America, coal covers almost 45% of the energy requirements of Asia as a whole, and over 50% in some countries, such as China and India. In 2003 coal represented 22.5% of the energy consumption of the United States, 14.9% of that of the European Union, and 21.4% of that of the ex-Soviet Union.
Coal consumption increased by 6.9% compared to the previous year, with the greatest change in consumptions occurring in Asia and the Pacific (10.3%), where in a number of cases (New Zealand, Hong Kong, the Philippines, China and Pakistan) there was growth of over 10%. China remains the major user of this energy source, accounting for 31% of its total energy consumption.
There was another substantial increase in consumption in Africa (5.7%), almost wholly attributable to South Africa, the main economic power and principal coal producer of the continent. Overall, the growth in energy demand produced an increase in the coal's share of the total world energy requirement. Oil and gas prices are increasing because of the regained competitiveness of the coal industry, which over the last decade has managed to maintain low costs and prices, thanks to a continuous, although slow, improvement in extraction technologies, the exploitation of opencast mines, and the reduced risk in terms of the security of the supply.
In the face of increased world demand, production grew for the third consecutive year (+5.9% higher than 2002), mainly because of the strong growth in production in Asia (+10.9%, of which 15.1% Chinese in origin) and in the ex-Soviet Union (+6.2%).
Almost 24% of world energy demand in 2003 was satisfied by natural gas, with an increase of 2% over the preceding year. This is a level that, although in line with the historical levels for the last decade, is lower than the rate of growth in overall energy consumption. The slowdown is due to the fact that the limits of supply capacity have been reached in North America, and natural gas prices rose, due to a high demand trend, which favoured the replacement of gas by more competitive energy sources. The replacement was mainly by coal. In all the other geographical areas the demand for natural gas grew faster than the demand for energy in general: by over 8% in Latin America and Africa, 5.6% in Asia and 4.6% in Western Europe.

World production grew by a total of 3.4% compared to 2002, notwithstanding the negative trend in North America, mentioned above. In the United States, the demand exceeding domestic production and imports through pipelines from Canada and Mexico is satisfied by imports of liquefied natural gas (LNG) from Trinidad and Tobago. Natural gas production in Western Europe grew by a modest 0.9%, due to an increase in production (+12%) in Norway, while in all the other areas (Netherlands, United Kingdom and Italy) production has been decreasing since 2001. In this area the gap between demand and production is covered by imports of LNG from Algeria and West Africa, and of natural gas from Algeria and Russia where production grew by 4.2%, and now accounts for 22% of natural gas production worldwide. Significant percentage increases in production were recorded in Central and South America and in Africa, where there is great potential. These last two areas together covered just 10% of world production in 2003.

So far as global electric power generation is concerned, in 2003 it displayed exactly the same trend as energy demand as a whole, with a growth of 2.9%, lower than the growth in GDP. Hydroelectric and electronuclear sources each satisfied 6.1% of the global primary energy requirement. Most electronuclear power generation is in OECD countries. During the year there was a 2% fall, due mainly to reduced nuclear power generation in Japan (-26.7%) because of the need to inspect and perform maintenance on a number of power stations in the last months of the year, and to a fall in the United States (-2.1%). These reductions were partially compensated for by the adoption of nuclear programmes in Argentina and South Africa. World hydroelectric power generation is mainly in OECD countries; North America alone accounts for 22.5% of total production, thanks to Canada (the first world producer) and to the United States (the third world producer), while the European Union accounts for 11.6% and the former USSR countries for 8.6%. However, during the year there was an

Table 3 - Contribution of renewable energy sources to the energy supply. 2002-2003 (Mtoe)

	World	OECD		EU - 15		Italy	
	2002	2002	2003	2002	2003	2002	2003
Total energy supply	10,230.7	5,345.7	5,390.8	1,489.4	1,513.1	172.7	180.7
Biomass	1,117.7	178.4	181.1	56.7	59.7	2.5	3.1
Solar, wind	8.8	7.6	8.2	3.8	4.4	0.2	0.2
Geothermal	41.5	24.8	26.3	3.8	5.2	3.5	4.8
Hydroelectric	223.7	105.8	104.7	24.1	24.0	3.4	3.2
Renewables Total	*1,391.6*	*316.6*	*320.3*	*88.4*	*93.4*	*9.6*	*11.3*
% Renewables	*13.60*	*5.92*	*5.94*	*5.94*	*6.17*	*5.54*	*6.24*

Source: International Energy Agency

Table 4 - Energy intensity by geographical area. Index numbers 1990=100

	1995	200	2001	2002	2003
North America	96.7	85.9	83.8	83.1	81.1
Central and Southern America	97.7	101.9	101.5	102.8	103.9
Western Europe*	91.4	84.4	84.1	82.5	83.2
Former USSR, EiT **, Turkey	11.5	97.7	94.7	90.9	88.7
Middle East	102.4	103.0	104.2	105.6	103.4
Africa	101.7	94.9	93.0	92.7	93.6
Asia and Pacific	95.5	79.0	79.4	83.1	84.0
World	92.9	82.0	81.1	81.5	81.2

Source: ENEA data processing of BP data

* Including the new ten EU member countries
** Economies in Transition: Bulgaria, Romania

increase of only 0.4% worldwide, because of low water levels in reservoirs.
Biomass and waste are worth to mention as they are among the sources of energy that are widely used in global terms, particularly in developing countries. These energy sources are increasingly being included in the OECD official statistics and energy balances of the developed countries. The International Energy Agency estimates for 2002 (the latest year for which data are available) indicated global values of about 1117 Mtoe, which represents about 10.9% of world energy consumption. It is reasonable to assume the same value for 2003, because this contribution has changed by only a small degree over the last few years (table 3).
Energy intensity, that is, the energy needed per unit of GDP (measured in dollars at 1995 prices), slightly decreased globally, compared to 2002, as a result of differing trends in the economic areas considered (table 4).
Energy intensity is decreasing in North America, the former Soviet Union and the Middle East, and increasing in Western Europe, Asia, Central and South America and in Africa. In Asia in particular, energy intensity is growing because of the increase in energy-intensive economic activities, and the increase in consumption in the transportation sector; in Western Europe the trend in energy intensity is due to growth in consumption in the domestic and services sectors, and small economic growth.

Environment

In November 2001, the Marrakech agreement, considered the role of the Kyoto Protocol "realistically", and assumed the principle of integrating the reasons and prospects for economic growth with those for reducing carbon dioxide emissions. The Marrakech agreement actually incorporated many of the observations previously formulated by the United States, and at the same time it defined procedures and methodologies to promote ratification of

the Protocol by Japan, Canada and Russia. It therefore contributed to the ratification of the Protocol by Canada and Japan. However, Australia, one of the nations considered important to reach the overall reduction level envisaged by the Protocol, decided not to ratify it, preferring a "national route" to reducing emissions without being subject to international legal obligations.
The United States confirmed its position of non-ratification of the Protocol, considering it too limiting and burdensome for the US economy, and during 2003 implemented some policies which, while not exactly alternative to the Protocol, are aimed at creating global programmes on a voluntary basis: these are essentially partnerships to develop a new energy economy based on hydrogen and on geological sequestration of the carbon produced by using fossil fuels.
After a scientific and economic assessment of the environmental "value" of the Protocol, and of the economic effects of its implementation at national level, Russia decided to ratify the treaty.
The Russian decision is crucial for the Protocol to come into force. In fact, for the Kyoto Protocol to come into force, it must be ratified by 55 countries, responsible for at least 55% of the CO_2 emissions of the industrialised countries (referred to 1990). So far the Protocol has been ratified by 104 countries, responsible for 43.9% of total CO_2 emissions. After the US withdrawal from Kyoto, the Russian Federation, which is responsible for 17.4% of total greenhouse gas emissions, plays a key role in making the treaty legally binding.
In this framework, the European Union has confirmed its commitment to reducing emissions, despite the US position.
However, after the Marrakech agreement, the possible options for reducing emissions are far more open that those available in the light of the "unilateral" criterion adopted by the decision of 17th June 1998.
In particular, the conclusions of the 9th Conference of the Parties (COP9) held in Italy in December 2003, about the use of carbon credits generated by reforestation projects in developing countries (Clean Development Mechanisms forestry projects) allow a greater flexibility in national choices, and promote a significant reduction in costs for the same quantity of reduced emissions.
Moreover, the start of the community system to trade CO_2 emission quotas, implemented in directive 2003/87/EC (the "Emissions Trading" directive) approved in October 2003, and in the so-called "Linking" directive, could introduce further elements of flexibility.

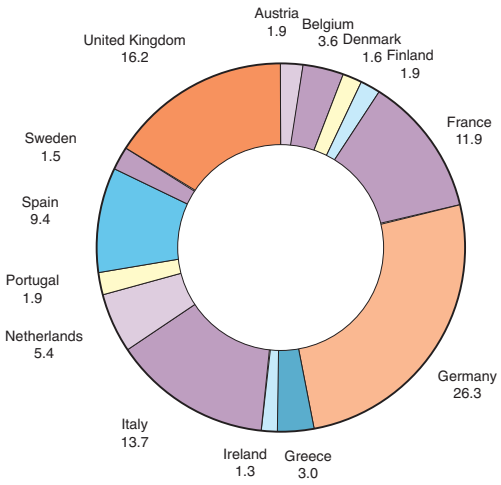
Directive 2003/87/EC institutes a system to trade greenhouse gas emission quotas within the European Union, so as to promote the reduction of these emissions according to cost-effectiveness and economic efficiency criteria.
The system may be summarised in the following items.

- The field of application of the directive is extended to the activities and gases listed in annex I to the directive; in particular, it concerns carbon dioxide emissions from energy combustion, ferrous metal production and transformation, mineral product processing, and wood pulp, paper, and cardboard production activities.

- The directive envisages a dual obligation for the plants it regulates:
  - the need to possess a permit to emit greenhouse gases into the atmosphere in order to operate;
  - the obligation to render, at the end of the year, a number of quotas (or rights) of emission equal to the greenhouse gas emissions during the year.
- The permit to emit greenhouse gases is issued by the competent authorities after they have checked that the operator of the plant is capable of monitoring its greenhouse gas emissions over time.
- The emission quotas are issued by the competent authorities to the operators of each plant regulated by the directive according to a national assignment plan; each quota gives a right to release a tonne of carbon dioxide equivalent.
- The national assignment plan is drawn up in compliance with the criteria contained in annex III to the directive; they include coherence with the national reduction targets, with the forecasts for emission growth, with the abatement potential and with the principles of maintaining competition. The assignment plan envisages assigning quotas at plant level for preset periods of time.
- Once they have been issued, the quotas can be bought or sold; both the operators of plants covered by the directive and third parties (intermediaries, non-governmental organisations, individuals) can participate in these transactions; the quota transfers are recorded in a national register.
- The operators of plants render the same number of emission quotas each year as the number of real emissions from the plants.
- The real emissions used in the ambit of the yielding of quotas by operators are the result of monitoring by the operators themselves, certified by a third party accredited by the competent authorities.
- Non-yielding of an emission quota will incur a fine of 40 euro in the period 2005-2007 and 100 euro thereafter; those emissions that are the subject of fines are not exonerated from the obligation to yield quotas.

The "Linking" directive, approved by the European Council and Parliament a few months after the "Emissions Trading" directive was approved, regulates the use of "emission credits" from Joint Implementation (JI) and Clean Development Mechanism (CDM) projects in the European market of greenhouse gas emission quotas.
Thanks to the "Linking" directive, operators of plants that fall within the field of action of the directive can decide to acquire emission credits by international technological cooperation rather than by work on the plants operating in the European internal markets, to return the quotas assigned to them. From this perspective, the Joint Implementation and Clean Development Mechanism initiatives can represent an extraordinary "driving force" to transfer "clean" technologies to emerging markets and to develop economic cooperation with the new players on the world market.
To summarise, the application of the two directives could represent a divergence from the traditional and consolidated European "command and control" culture to an ap-

Figure 3 - Contribution of each country to the total CO_2 energy emissions in Europe. 2002 (%)



Note: for graphic reasons the 0.2% share of Luxembourg has not been included
Source: ENEA data processing of European Environment Agency data, 2004

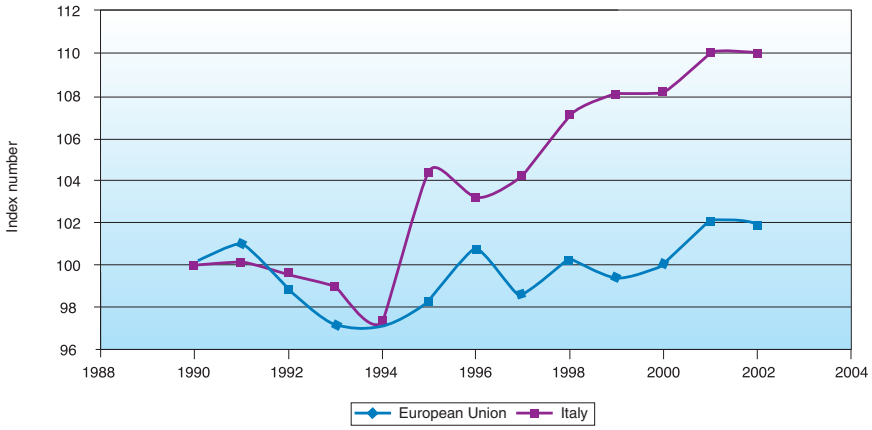
proach that is oriented towards the use of market mechanisms to provide incentives for adopting better technologies.
Under the Kyoto Protocol, the European Union has made a commitment to reduce by 8% its greenhouse gas emissions with respect to the 1990 emission levels by the year 2010. Governments' attention is focussed mainly on CO_2 emissions (figure 3), which represent more than 80% of all greenhouse gas emissions in the countries listed in Annex I.
In 2002, the total CO_2 emissions of the European Union energy system increased by almost 2%, with respect to the 1990 figure. In the same year, Italy recorded an overall increase in the emissions of about 9%, with respect to 1990, as shown in figure 4.
This result for the European Union was obtained mainly thanks to Germany, which, together with the United Kingdom and Sweden, were able to achieve reductions in emissions with respect to the base year.

Italy

Economy

In Italy the economic slowdown that started in the second quarter of 2001 (table 5) continued in 2003. GDP increased by 0.4% (the same as in 2002) thanks mainly to the contribution made by domestic final demand. The recovery in consumer spending (1.3% in 2003, up from 0.5% in 2002) weakened during the year because of worsening consumer confidence, linked to the widespread fear of gradual impoverishment of family disposable

Figure 4 - CO_2 emissions from the energy system in Italy and in Europe (index numbers 1990=100). 1990-2002



Source: ENEA data processing of European Environment Agency data, 2003

income, influenced by the vicissitudes of large industrial groups and expectations of the reform of the social security system.

Fixed investments decreased during the year by 2.1% in real terms, despite favourable borrowing conditions: this happened because a high unused production capacity was available (the degree of use of plants fell further in 2003, to the minimum level of 1997), which aggravated entrepreneurs' uncertainty about the prospects for the economy. The growth in investments in construction (+1.8%) was the only exception, thanks to domestic building prompted by low mortgage rates and rising property share prices. Moreover, the foreign component of demand had the overall effect of slowing down GDP growth by some 0.9%, after a slight decrease in imports accompanied by a sharp fall in exports (-3.9%).

The fall in exports mainly involved Italy's traditional and most labour intensive industries sectors of specialisation, such as clothing and furnishings, particularly exposed to compe-

Table 5 - Calculation of resources and uses. Annual variation (%)* 2001-2003

	Gross Domestic Product	Import and fob services	Final national consumption	Fixed gross stock investments	Stock variations	Export of goods and fob services
2001	1.7	0.7	1.4	1.6	-373.7	2.2
2002	0.4	-0.9	0.5	0.5	-392.7	-3.2
2003	0.4	-0.9	1.3	-2.1	174.1	-3.9

* Original data adjusted to the different number of working days. Constant price values
Source: ENEA data processing of ISTAT data

tition from countries with lower labour costs. In 2003, the rate of inflation in Italy was 2.8% (compared to 2.6% in 2002). The rise in the price of regulated items, connected mainly to the rise in indirect taxation and higher energy tariffs, affected this increase in the inflation rate. The difference in inflation rate compared to the mean for the euro zone increased from 0.3% in 2002 to 0.7% in 2003.

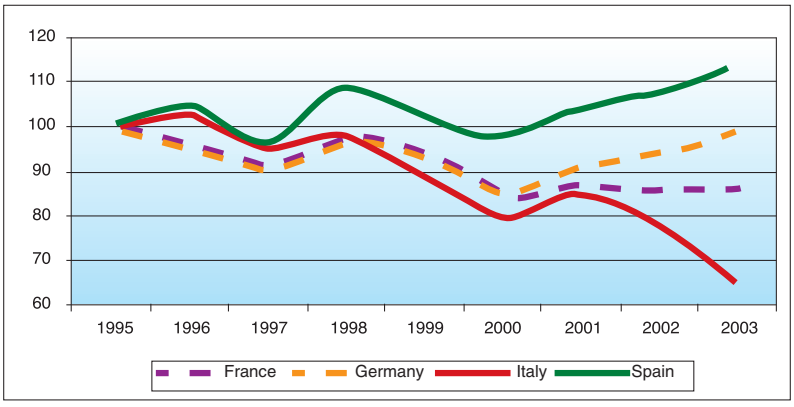
Growth in employment slowed down to 1% from the 1.5% of the previous year, although this was due to fixed term contracts; the labour cost per unit (which includes employees' social security contributions) also increased by 3.8% in 2003, because of the many contracts signed in the second half of the year, which tended to set pay increases in line with the expected inflation rates rather than the officially planned inflation rates, and also forecast a substantial narrowing of the gap between actual and planned inflation. All of this contributed to accelerate the cost of labour per unit product (CLUP). The increase in CLUP was 4.2% higher than Italy's principal European partners and one percentage point higher than the previous year.

This data was principally influenced by the fall in productivity, which over the year affected both the service sector and industry. In fact in 2003 the loss of market share by Italian products continued falling from the 4.5% of 1995 to 3%, while in the other three major countries in the euro area goods exports showed a more favourable trend (figure 5): exports by Germany and Spain grew, and France's fell only slightly. However, all three countries' shares of the world market have fallen less than Italy's since 1995.

The differing competitiveness of the products of the countries analysed can be attributed to their different productivity trends. The loss of competitiveness in Italy is fuelled by several structural elements.

Since the 1990s there has been unprecedented technological development in all the major industrial countries, stimulating growing diversification in their competitive positioning

Figure 5 - Export share of the main euro zone countries in global trade (export of goods and services at constant prices; 1995=100 indexes)



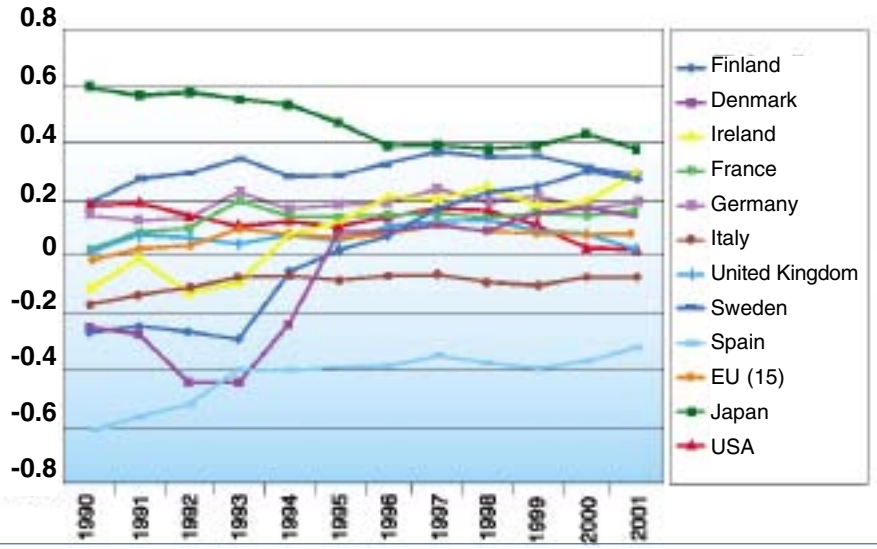
Source: ENEA data processing of WTO and Bank of Italy data

and, in particular, growing specialisation by individual countries in specific high tech sectors. Each country's capacity to compete in high tech production also appears to be increasingly important in determining the size of a "foreign link" component, due to the steadily increasing levels of imports of high tech goods throughout the industrialised world.

In international comparisons, the recovery of their competitive positions by the European 15 in high tech production has allowed the technology gap with the United States and Japan to be reduced somewhat. The countries of the European Union have contributed to this recovery in various specific and national ways, with important differences that allow the substantial contribution made by the major economies of the Old World (France, Germany and the United Kingdom) to be distinguished from the true "technological take-off" of a series of "small" Northern European economies (Ireland, Sweden, Finland and Denmark) which have by now assumed positions of global leadership.

Italy does not figure in this context at all, and forms part of a wholly marginal area of Mediterranean countries (figure 6). The reasons for the weak technological competitiveness of Italy should be sought in both the situation of accumulated delay in production systems oriented towards medium technological intensity sectors, and in its industrial fabric, extremely fragmented into small and medium sized enterprises, as well as the inadequate levels of investment in R&D in both the public and the private sectors. In particular, Japanese and US enterprises invest over 2% of the GDP in research, a figure that is four times the amount invested in Italy, and the research investments of Germany, France and the United Kingdom are only a little less. Italy has maintained its technological non-specialisation, measured by the ratio of R&D to added value, and its distance from the

Figure 6 - Normalized trade balance in high-tech products



Source: ENEA Observatory on Italy in International Technological Competition

other countries in pharmaceuticals, mechanical engineering and even the textile sector, where specialised production seemed to be more concentrated in 2000, and where the technological delay is most worrying, remains high.
The outcome of such a notable weakening of Italy's technology base can also be seen in the trend in patents: Italy's share of world high-tech patents was just 1.65% in the period 1999-2001, a loss of over 23% since the start of the decade, in the context of a 5% increase in the EU as a whole. The low propensity for innovation of Italian enterprises is also accompanied by long-term investment costs higher than the European Union average. These are essentially targeted at replacing the labour factor. The dynamics of productivity remain stagnant, and the degree of use of plant is lower than that of Italy's European partners, while the cost of investments has a growing effect on the balance of payments. In this context there is room for an intervention by the public sector to facilitate the more efficient allocation of national savings, and to take action to direct and stimulate innovation.
The forecasts formulated by the OECD for 2004 foresee growth of 0.9% in Italy's GDP, rising to 1.9% in 2005; this trend is confirmed by the data on the first six months of the year, while the Euro zone average is likely to be around 1.6% in 2004, and then grow to 2.4% in 2005. According to the OECD, growth in Italy is slowed down by the current uncertainties about corporate governance; these uncertainties, together with decreasing public saving and the likelihood that the deficit will increase, might on the one hand induce greater caution in private savings, and on the other cause a credit squeeze, which would slow down investments.

Energy demand

The overall demand for primary energy increased by 2.9% during 2003, and energy intensity worsened (table 6), compared to the previous year.
Analysis of the primary energy requirement by source shows a reduction of 1.4% in the consumption of oil and oil products, and a parallel increase in the demand for fossil fuels, particularly coal and natural gas. The demand for these fuels grew by 8% and 9.4% respectively, as they were increasingly used as replacement fuels for electric power generation.
Considering the final energy consumption, the increase in consumption recorded in the households and tertiary sector is particularly significant (table 7): from 40.5 Mtoe in 2002 to 43.6 Mtoe in 2003 (+8.4%).
The reason for this growth lies partly in the weather conditions (cold winters, very hot summers) and the consequent increased need for conditioning, and in factors related to income, which continue to favour consumer spending (greater penetration of domestic appliances and, even more so, electronic devices, increased living space per capita) and, finally, social factors. The increased consumption particularly affected natural gas (+10.4% compared to 2002), oil products (+7.2%), and electric power (+5%), while consumption of solid fuels and renewable energy sources also grew. Consumption by the transport sector increased from 42.5 Mtoe in 2002 to 43.8 Mtoe in 2003 (+2.3%); the lower increase with respect to the other sectors is due to the approaching saturation limit, particularly in road transport.

Table 6 - Primary energy demand in Italy in 2001-2003 (Mtoe)

	2001	2002	2003	2003/2002(%)
Solid fuels	13.7	14.2	15.3	8.0
Natural gas	58.5	58.1	63.1	9.4
Import of electric power (A)	10.7	11.1	11.2	0.6
Oil	88.4	91.4	90.2	-1.4
Low cost fuels (orimulsion)	1.7	1.7		
Renewables (A)	13.8	12.6	12.6	-0.3
Total	**186.8**	**187.6**	**192.9**	**2.9**
GDP (billions of € in liras 1995)	1,033.0	1,036.7	1,039.4	2.6
Energy intensity (toe/M€)	180.8	180.9	185.6	2.6

(A) kWh were changed into toe, based on calories needed to produce 1 thermoelectric kWh
Source: MAP – National Energy Balance 2003

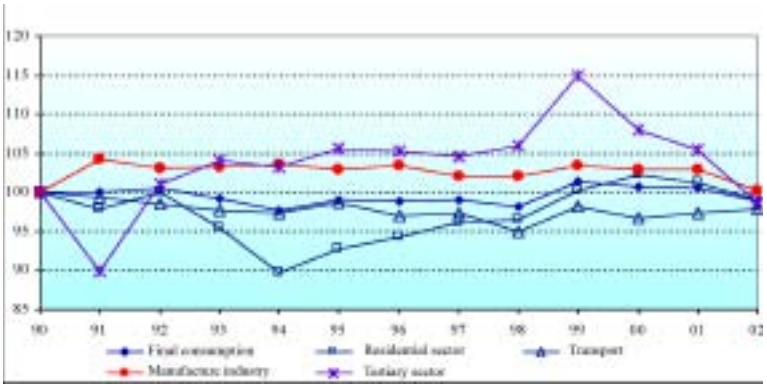
In this sector consumption of oil products exhibited growth of 2.1% thanks to the growth of diesel fuel as a replacement for petrol. Finally, industrial consumption showed a very modest increase: just 1.4%.
Figure 7 shows the change in the composite energy efficiency indexes by economic macro sectors, created using the ODYSSEE database, and considering 1990 as base year. An index

Table 7 - Synopsis of National Energy Balance 2003 (Mtoe)

	Solid fuels	Natural gas	Oil products	Renewables	Electric power	Total
Production	0.6	11.3	5.5	12.1	-	29.5
Imports	14.5	51.2	107.4	0.5	11.3	184.9
Exports	0.1	-	22.1	0.0	0.1	22.3
Stock variations	-0.3	-1.1	0.6	0.0	-	-0.8
Availability for domestic consumption	15.3	63.6	90.2	12.6	11.2	192.9
Gross domestic consumption and losses in the energy sector	-1.0	-0.5	-6.1	0.0	-44.5	-52.1
Transformation into electric power	-10.3	-21.8	-15.4	-10.8	58.3	-
End uses	4.0	41.3	68.7	1.8	25.0	140.8
Industry	3.8	16.8	6.8	0.3	11.9	39.6
Transport	-	0.4	42.4	0.2	0.8	43.8
Residential and services	0.1	23.1	7.4	1.1	11.9	43.6
Agriculture	-	0.1	2.6	0.2	0.4	3.3
Non-energy uses	0.1	0.9	6.2	-	-	7.2
Bunkering	-	-	3.3	-	-	3.3

Source: MAP – National Energy Balance 2003

Figure 7 - ODEX energy efficiency indexes in Italy. 1990-2002 (1990=100)



Source: ODYSSEE data

value of less than 100 for the year 2000 represents an improvement in the energy efficiency of the sector considered. In the period 1990-2002, the energy efficiency indicator in final consumption, domestic consumption and transport, oscillated around the base year value, or at most was slightly better. In the services sector, after a period in which it worsened (from 1992 to 1999), the indicator improved rapidly in the last three years. In the transport sector there was a small improvement of 2.2% over the period of time considered. Finally, the industrial sector is the only one where the index has worsened, albeit only slightly: it remained higher than the initial value throughout the period considered.

Energy supply

In 2003, national production of energy sources fell slightly (-1%) compared to the previous year.

There was a significant reduction in the production of natural gas (-6.3% compared to 2002), and a lesser reduction in the production of crude oil, due to the progressive exhaustion of the fields currently in use. The continuing negative trend in national production of natural gas and oil worsened the country's energy dependence that increased from 84.1% in 2002 to 84.6% in 2003 (table 8).

The increase in energy dependence in 2003 translated into an increase in Italy's foreign energy bill which, although benefiting from the strengthening of the euro against the dollar, was affected by the increase in the volumes of import, particularly those of natural gas. The total energy bill (table 9) in 2003 was therefore some 104 million euro higher than the preceding year, while at the same time the cost of oil imports fell slightly because of the devaluation of the dollar, which neutralised the effects of the rise in crude prices; expenditure on natural gas increased by about 9%, from 7,921 million euro in 2002 to 8,646 million in 2003.

Table 8 - Italy energy dependance by source. 2002-2003 (%)

	Solid fuels	Natural gas	Oil	Total
2000	97.8	77.6	95.1	83.7
2001	96.5	78.2	95.4	83.6
2002	96.0	80.2	94.0	84.1
2003	96.0	81.9	93.9	84.6

Source: ENEA data processing of MAP data

In 2003 Italy produced 5,540 million tons of crude oil (equal to roughly 110 thousand b/d), and 13,996 billion standard m^3 of natural gas, an increase of 1% in oil and a decrease of 6% in natural gas, compared to the previous year.
The small increase in oil production is due to the gradual way the Val d'Agri oil wells have come into production, and to the fact that the development of the reserves found in Basilicata in the Valle del Sairo and Val Calastra (the Tempa Rossa field) has not yet started; these are likely to make a further significant contribution to national production. At present 82% of crude oil production is onshore, and the remainder is from offshore fields. Imports of crude oil increased by 4.1% compared to 2002, although there were notable falls in imports of semi-processed products (7.4 million tons, equal to -6.6%), finished products (-2.2%) and heavy crude emulsions or orimulsions (-18.1%).
70% of oil products were obtained from the Middle East and North Africa, and the remaining 30% from the Russian Federation and other European countries.
For natural gas, 2003 confirmed the decline in national production, started in 1994. The largest component of nationally produced gas is from the Adriatic Sea, which also holds 46% of the country's reserves. Since natural gas has, in the last few years, become the energy source most widely used to generate electric power (from 16% in 1992 to 40.6% in 2003), increasing recourse is made to imports, which covered 80% of requirements in 2003). Natural gas was imported from Russia (35.9%) and Algeria (34.5%), as well as limited quantities from other European countries and 5.6% from Africa in the form of LNG. Given the growing importance of natural gas, there are many projects to build new pipelines, such as the Galsi, which will link Algeria to France, passing through Sardinia, or the pipeline between Greece and Italy financed by the European Commission as part of the regulation of the Trans European Network (TEN), and the extension of existing pipelines.

Table 9 - Italy: estimate of the "energy bill". 1995-2003 (M€)

	1995	1998	1999	2000	2001	2002	2003
Solid fuels	990	783	753	996	1,223	1,142	1,129
Natural gas	2,661	3,424	3,642	7,834	8,782	7,921	8,646
Oil	9,023	7,312	9,653	18,651	15,985	15,511	15,003
Others	1,563	1,459	1,418	1,524	1,751	1,867	1,767
Total	**14,237**	**12,978**	**15,466**	**29,005**	**27,741**	**26,441**	**26,545**

Source: Unione Petrolifera

Table 10 - Electric power energy balance in Italy. 2002-2003 (GWh)

	2002	2003	Variations 2002/03 (%)
Gross hydroelectric generation	47,262	44,277	-6.3
Gross thermoelectric generation	231,069	242,784	5.1
Gross geothermal generation	4,662	5,341	14.5
Gross wind and photovoltaic generation	1,408	1463	3.9
Total gross generation	**284,401**	**293,865**	**3.3**
Energy for services	13,619	13,682	0.5
Total net generation	**270,783**	**280,183**	**3.5**
Energy for pumping	10,654	10,492	-1.5
Total net for consumption	**260,129**	**269,691**	**3.7**
Import	51,519	51,486	-0.1
Export	922	518	-43.8
Total Italian demand	**310,726**	**320,659**	**3.2**
Losses	19,766	20,870	4.5
Total consumption	**290,960**	**299,789**	**2.8**

Source: GRTN (provisional data 2003)

Although the natural gas market was fully opened on 1st January 2003, there have not in fact been any significant transfers of domestic customers from one supplier to another, because there is little effective competition between local companies.

The only coal resource in Italy is concentrated in the Sulcis Iglesiente basin, in South Western Sardinia, where extraction activities, suspended in 1972, were resumed in 1997 as part of the Plan to rid the area of pollution. Total imports of solid fossil fuels increased by about 11%, from 19.8 million tons in 2002 to 22.1 million tons in 2003: this was mainly accounted for by steam-generating coal (+13%) and by other types of coal (+32%), while coking coal imports fell by 9%. Exports of solid fuels were minimal, directed mainly to other EU countries and the remaining part to some other countries, and over 86% of the exports may be ascribed to flows of metallurgical coke.

In 2003 the demand for electric power on the national grid was 320,659 GWh, 3.2% higher than the previous year (table 10). The above demand was satisfied for 84.1% by national power generation, which grew by 3.3% compared to 2002, and for 15.9% by the import-export balance with abroad, a little higher (+0,7%) than the 2002 value.

15.1% of the gross national power was generated from hydroelectric sources, 82.6% from thermal sources and 2.3% from geothermal and renewable sources (excluding biomass). Thermal generation has increased (+5.1%) to meet the increased demand on the national grid and the simultaneous fall in hydroelectric power generation (-6.3%). Energy from

Table 11 - Energy from renewable energy sources in Italy in equivalent substituted fossil fuels. 1995-2003 (ktoe)*

Energy sources	1995	2000	2001	2002	2003
Hydroelectric[1]	8,312	9,725	10,298	8,694	8,068
Wind	2	124	259	309	321
Photovoltaic solar	3	4	4	4	5
Thermal solar	7	11	11	14	16
Geothermal	969	1,248	1,204	1,239	1,388
Waste	97	461	721	818	1,038
Wood and similar[2]	1,976	2,344	2,475	2,489	2,782
Biofuels	65	66	87	94	177
Biogas	29	162	196	270	296
Total	**11,460**	**14,144**	**15,255**	**13,931**	**14,092**
of which non-traditional[3]	1,247	2,017	2,519	2,932	3,536

[1] Only electric power from natural supply evaluated at 2200 kcal/kWh

[2] Excluding ENEA investigation on firewood consumption in homes

[3] Wind, solar, waste, wood (excluding firewood in homes), biofuels, biogas

* In addition, 9.8 TWh produced from industrial waste, corresponding to 2.1 Mtoe substituted, is to be considered

Source: ENEA data processing of data from various sources

geothermal and renewable sources showed a reasonable increase (+11.4%), but its overall contribution to the total demand was nearly unchanged (+0.2%).

The contribution made by renewable energy sources (RES) to the national energy balance has increased about 23% between 1995 and 2003 (an average of +2.9% per year) and at the same time energy produced from non-traditional RES has almost tripled, from just over 10% to over 25% of the total renewable energy (table 11).

A total of 48 TWh of electric power was produced from renewable sources in 2003, equivalent to 14% of gross domestic consumption [1] of electric power and over 16% of gross domestic production (293.9 TWh). Compared to the previous year, there was a fall in RES energy production that is exclusively attributable to the reduced contribution of hydroelectric sources. All the other renewable energy sources recorded positive annual growth rates (table 12).

The production of heat from RES originates mainly from:

- solar heat collectors (estimated at 673 TJ in 2003);
- direct uses of geothermal energy (8900 TJ);
- remote heating systems using wood, located mainly in Lombardy, Piedmont and Trentino Sud Tirol (about 1200 TJ in 2003);
- industrial plants that use processing residues (woods and similar products) for heat production (39,600 TJ);
- heat recovered from solid urban waste in heat treatment plants (estimated at 5700 TJ in 2003);

[1] The gross domestic consumption is the gross production of electric power plus the foreign trade balance.

Table 12 - Electric power from renewables. 1995-2003 (GWh)

	1995	1998	1999	2000	2001	2002	2003
Hydroelectric	37,781	41,213	45,358	44,205	46,810	39,519	36,674
Hydroelectric < 10 MW	7,440	8,320	8,602	8,117	8,657	8,048	7,192
Hydroelectric > 10 MW	30,341	32,893	36,756	36,088	38,154	31,472	29,483
Wind	10	231	403	563	1,179	1,404	1,458
Photovoltaic solar*	13	14	15	16	16	18	23
Geothermal	3,436	4,214	4,403	4,705	4,507	4,662	5,341
Urban solid waste	168	464	653	804	1,259	1,428	1,812
Wood	116	271	587	537	644	1,052	1,648
Biogas	103	494	583	566	684	943	1,033
A - Total	**41,627**	**46,901**	**52,002**	**51,396**	**55,100**	**49,027**	**47,989**
B - Gross domestic consumption (TWh)	**279**	**301**	**308**	**321**	**327**	**336**	**345**
A/B (%)	**15**	**16**	**17**	**16**	**17**	**15**	**14**

* ENEA estimates

Source: ENEA data processing of GRNT data

- industrial plants connected to the electric power grid, that burn wood and wood residues for electric power generation and recover the heat by combined heat and power (over 5400 TJ in 2003);
- biogas-fuelled electric power generation plants that recover heat by combined heat and power (over 1600 TJ in 2003).

However, wood burning in the domestic sector accounts for by far the largest contribution (46,055 TJ in 2003). This figure takes wood biomass sales, obtained from national statistics, into account. Most of the wood biomass consumed in the domestic sector, however, is not included in the official figures. A statistical investigation of Italian domestic use by a specialised company commissioned by ENEA found that about 14 Mt of wood (149,900 TJ in 2002) is burnt in homes in fires and stoves, mainly from non-commercial sources.

In recent years there has been a growing use of wood chips and pellets in automatic systems used for domestic heating; these systems are fuelled using products already available (such as olive press cake) and saw mill waste, or with imported material (an estimated 70,000 tons of pellets were produced in 2001, of a total national consumption of around 100,000 tons).

Scenarios

An evaluation of the "trend" evolution of the Italian energy system to 2020, produced using the Markal model, is shown in figures 8 and 9.

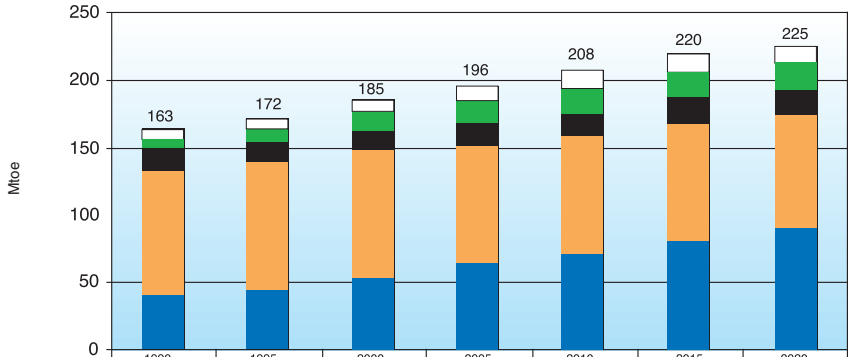
In the first decade of the scenario energy consumption increases at an average rate of 1.2%

per year (the same as in the 1990s), but increases at an annual rate of 0.8% in the second decade. As illustrated in figure 8 and 9, the current trend for natural gas to take the place of oil persists (mainly for electric power generation) and their respective quotas of total consumptions continue to converge until gas becomes the primary source in the Italian energy system by the end of the next decade. However, this trend scenario does not lead to any improvements over the current situation: total dependence remains around 85% for the entire time period (with a tendency to increase slightly). Moreover, renewable energy sources remain marginal, even though the scenario incorporates the 0.35% per year rise from 2004 to 2006 in the obligatory threshold for Green Certificates, and the latter remain well below 10% of total energy consumption.

Finally, CO_2 emissions, which in this scenario are not subject to any limits, increase throughout the period at an average rate of 0.7% per year, as shown in figure 10.

The rise in emissions is relatively modest in the first five years (+0.5% per year on average), thanks to the fall in emissions in the industrial sector and the steady emission level in both the domestic and the electric power generation sectors (due to the replacement of fuel oil by natural gas and the increase in imports), while there is no slowdown in transport emissions; after 2005 emissions start to rise again at higher rates (an average ~+0.9% per year until 2015) as the factors that slowed it down in the previous five-year period lose their impact. In 2010, the median year of the reference period for the Kyoto Protocol, the emissions forecast in this scenario are 7% higher than the 2000 values, and 12% higher than 1990 values, despite a commitment for Italy to reduce all greenhouse gas emissions by about 6.5%.

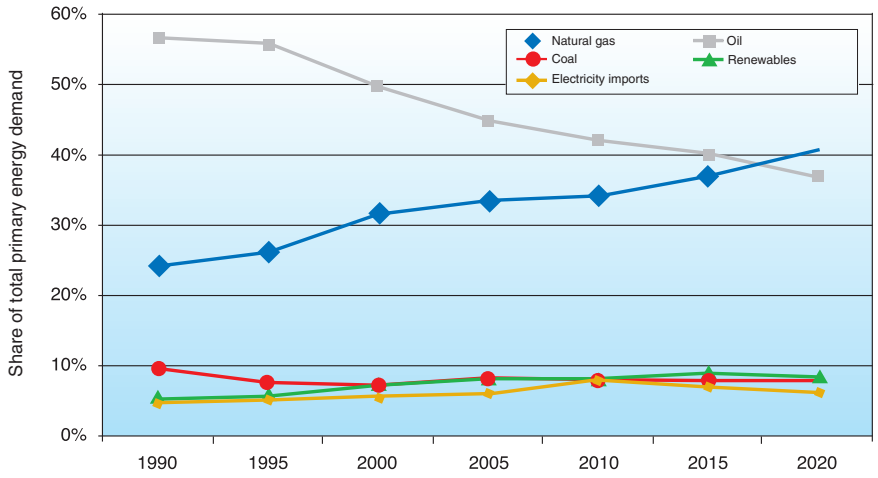
Figure 8 - Trend scenario: evolution of primary energy demand (Mtoe)



	1990	1995	2000	2005	2010	2015	2020
Electricity imports	7,6	8,2	9,6	12,2	15,3	15,0	14,2
Renewables	8,4	10,4	12,9	15,7	17,4	19,0	19,2
Coal	15,8	12,5	12,9	15,5	16,2	16,8	17,8
Oil	92,5	95,7	91,5	87,4	87,4	87,2	83,2
Natural gas	39,1	44,8	58,4	65,2	71,5	81,5	90,8

Source: ENEA and APAT data processing

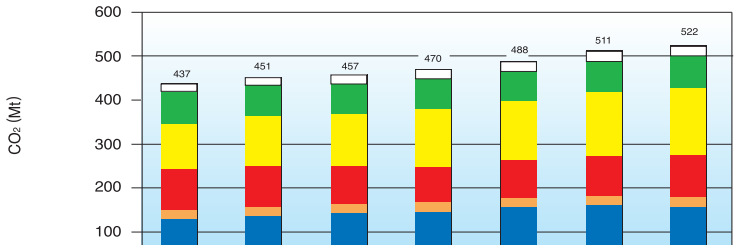
Figure 9 - Trend scenario: share of single energy sources of total demand (%)



Sources: ENEA and APAT data processing

A further evaluation of the evolution of the energy system, taking the current rapid rise in energy prices into account, so as to examine the possible impact of a continuing situation of sustained rises in energy prices is shown in figure 11 ("high prices" scenario). This scenario hypothesises that the price of oil will rise during 2005 from the $26/barrel of the trend scenario to about $34 barrel, and that this difference will remain constant throughout the time

Figure 10 - Trend scenario: sectoral CO_2 emissions in the energy system (Mt)

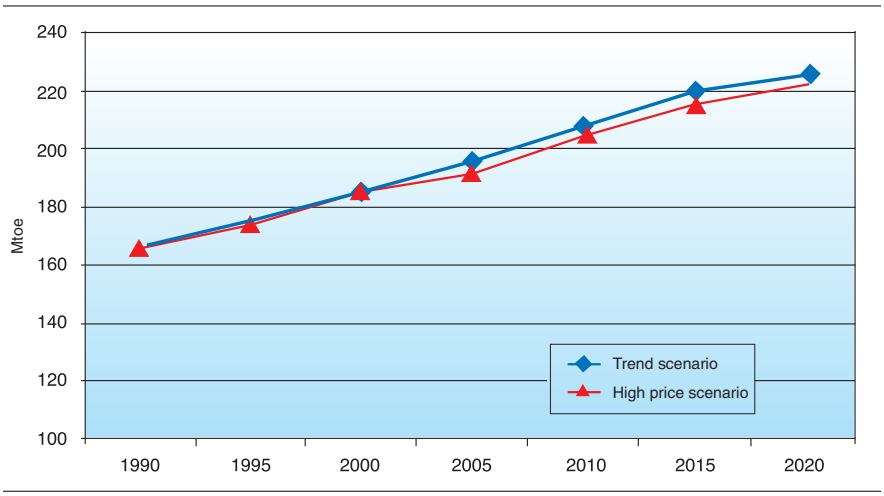


	1990	1995	2000	2005	2010	2015	2020
Process emissions	22	21	22	23	23	24	24
Civil	73	88	89	89	70	73	72
Transport	103	115	122	131	135	144	152
Industry	96	94	84	84	89	94	98
Energy industries	19	20	19	19	18	18	20
Power plants	125	133	141	142	152	159	157

Note: sectoral values for the years (1990-2002) have been calculated using the same methodology employed for the following years, approximating national emission data with a margin of error of 2-3%

Sources: ENEA and APAT data processing

Figure 11 - Evolution of primary energy consumption in the trend scenario and in the high price scenario (Mtoe)



Source: ENEA data processing

period of the scenario. The first notable result of the high price scenario is the reduction in total primary energy consumption compared to the trend evolution (figure 11): consumption is already about 4 Mtoe lower in 2005, and subsequently the difference between the two scenarios remains substantially constant, at between 3 and 4 Mtoe.

In terms of sources, the principal effect of a permanent rise in energy prices seems to be an acceleration of the replacement of oil by natural gas that is more marked than in the trend scenario, and that grows over time.

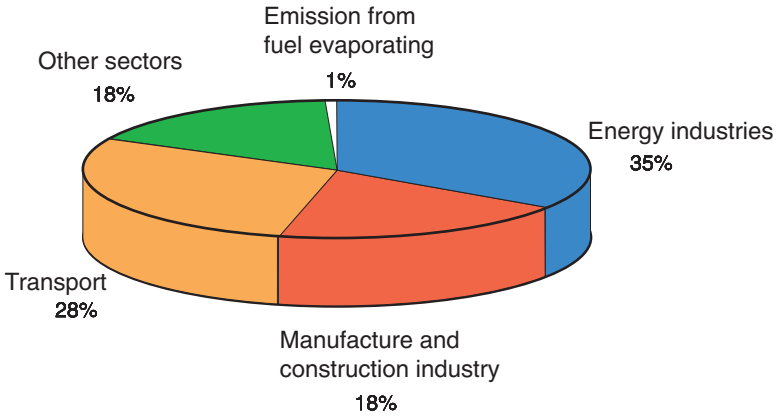
Finally, a significant consequence of the different evolution of the energy system in this scenario is that emissions of carbon dioxide (by the energy sector) are consistently lower than in the trend scenario. In fact CO_2 emissions actually fall, in percentage terms, to between 2 and 3%, thanks to the substantial change in fuel mix in the electric power sector, as well as in industry and in the domestic sector.

Environment

So far as Italian emissions of greenhouse gases in 2002 are concerned, and of CO_2 in particular, figures 12-14 supply some important information. The Italian energy sector as a whole was responsible for about 443 Mt of carbon dioxide emissions in 2002. 35% of these emissions originated from energy transformation processes, 28.2% from the transport sector, 18% from manufacturing and construction industries and a further 18% from the other sectors (figure 12).

Figure 13, however, illustrates the evolution of the macro sectors on a two-year basis, and

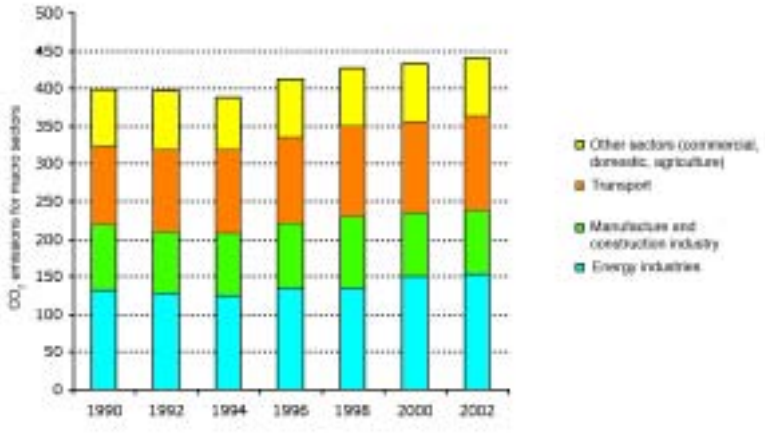
Figure 12 - CO_2 emissions from the energy system in Italy. 2002 (Gg)



Source: APAT, 2004

shows that energy industry emissions increased significantly over the past decade, despite several oscillations, while the transport sector increased steadily. The transport sector is responsible for the highest increase (22.7%) over 1990, followed by the energy production and transformation sector (15.3%). Only manufacturing and construction industries showed a fall in emission levels (3.3%), attributable partly to an improvement in the technologies used and improved energy efficiency, but also to the production crisis in some industrial sectors (figure 14).

Figure 13 - CO_2 emissions for energy macro sectors in Italy. 1990-2002 (Tg)

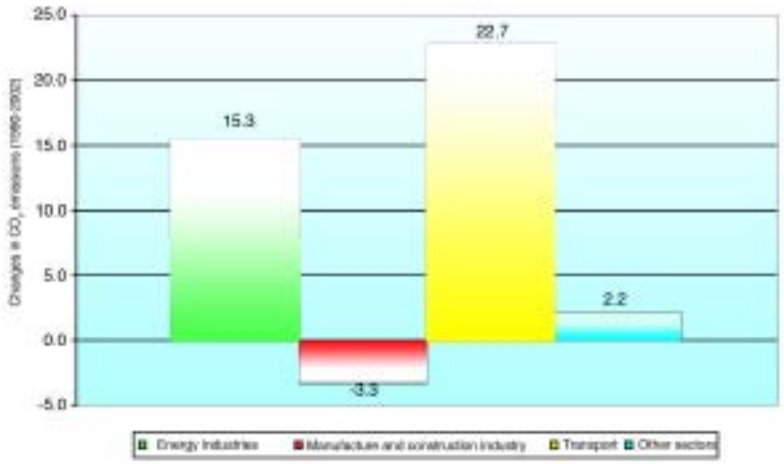


Source: ENEA data processing of APAT data, 2004

These data indicate that Italian emissions are on a growth curve that makes the reduction commitments made at the time the Kyoto Protocol was ratified, and the "burden sharing" agreements made with the 15 European Union countries, objectively difficult to respect.
The measures contained in CIPE (the Italian Inter-ministerial Committee for Economic Planning) resolution 123/200, and described in greater detail in the national plan for the reduction of greenhouse gas emissions, were formulated on the basis of the indications in the law ratifying the Kyoto Protocol of 1 June 2002, and taking the fundamental role of the energy system in the development of the country into account.
In particular, they take three principal criteria into account:

1. the programmes to reduce emissions in the domestic market must assume the high energy efficiency standards and the low "carbon intensity" of the Italian economy as the starting point. The dimension and type of national measures to reduce emissions must consider the need not to have negative effects on the competitiveness and efficiency of the Italian economy;
2. the "national" capacity to absorb atmospheric carbon must be optimised, whether through new inventory and a more efficient management of forestry and woodland resources, or by planting new forests, bearing in mind the objective of contributing to the hydro geological safety of the territory, while also increasing the volume of biomass available for the production of energy from renewable sources;
3. programmes to purchase "carbon credits" and "emission credits" using the mechanisms of the Kyoto Protocol Clean Development Mechanism and Joint Implementation must be promoted and facilitated, by participating in the Carbon

Figure 14 - Changes in CO_2 emissions in the main energy macro sectors in Italy. 1990-2002 (%)



Source: ENEA data processing of APAT data, 2004

Funds created by international financial institutions and the national agencies of developing countries and transition economy countries.

On the basis of these premises the plan identifies the programmes and measures to be implemented to respect the objective of reducing greenhouse gas emissions attributed to Italy. At the same time the plan establishes the procedures for monitoring and updating the measures.

The reference data of the plan, updated to September 2004, are as follows:

- by 2008-2012, emissions must be reduced by 6.5% with respect to 1990, that is, emissions must fall from the 508.0 million of tons of CO_2 equivalents ($MtCO_2eq$) of 1990 to 475.0 $MtCO_2eq$. So the theoretical "gap" to bridge is 33 $MtCO_2eq$.;
- in 2002 emissions totalled 553.8 $MtCO_2eq$, and according to the "trend scenario" (the scenario that will take place if no measures are taken), greenhouse gas emissions will total 613.3 $MtCO_2eq$ in 2010;
- considering the effects of the measures identified on 30 June 2002, although still implemented, which together attempt to achieve the objective of reducing emissions, in 2010 emissions are estimated to equal 563.7 $MtCO_2eq$., compared to the 613.3 $MtCO_2eq$ of the "trend scenario". This is the so-called "reference scenario", which leaves a gap of 88.7 $MTCO_2eq$. These measures do not only include national measures, but also the many bilateral cooperation initiatives taken by the Italian Government, as part of Joint Implementation and Clean Development Mechanism projects;
- measures at national level to absorb carbon in the agriculture and forestry sector include initiatives to increase and improve the management of forest and woodland areas, restoration of abandoned territory, protection of territory by forestation and reforestation. These measures may permit an increase in carbon absorption capacity corresponding to an equivalent reduction of 10.8 $MtCO_2eq$ in emissions. The gap that separates our country from achieving the Kyoto objective is thereby reduced to a 77.9 $MtCO_2eq$.;
- to bridge the gap a set of options has been identified as "further measures" to achieve the best result at the lowest cost
  - at national level, in the energy, industry, services, transport, agriculture and waste sectors, with a potential reduction of up to 47 $MtCO_2eq$.;
  - at international level, through cooperation projects in the energy and forestry sectors under the JI and CDM mechanisms, with a potential reduction of up to 48 $MtCO_2eq$.

As mentioned above, the gap we need to bridge to achieve our Kyoto objective, which is 77.9 $MtCO_2eq$., requires our country to make a considerable effort.

In general, the measures identified with the best efficiency and lowest cost criterion refer,

[2] The scenarios used for the national reduction Plan were developed using the CEPRIG model, and include industrial and agricultural emissions as well as those from the energy system.

at least for 40-50%, to programmes and initiatives to be implemented using the international cooperation mechanisms contained in the Kyoto Protocol. The national plan to reduce emission of the gases responsible for the greenhouse effect therefore constitutes an agenda and a guide for the sustainable development of Italy, and for the promotion of a new role for Italian enterprises in the international markets of clean technologies to protect the global environment.

The reference criteria for the definition of the national plan for the reduction of emissions (points 1-3 examined above) have also oriented the regulations approved by the government to implement the "Emissions Trading" directive in Italy. The political objectives for the economic development of the country imply that the gap does not involve imposing such burdens in the industrial sector as will compromise its competitiveness. Therefore, our gap with the Kyoto objective must be bridged recurring to the Kyoto flexibility mechanisms for at least 50% of the reduction effort (a choice compatible with current decisions in international forums).

In fact, this strategy appears to be the only viable one, although it is true that use of the flexible JI/CDM mechanisms involves transferring economic resources outside the national system, limiting any benefits that might have been associated with these resources if they had been invested in Italy; however, it is evident that these benefits are less than the increased cost of the national measures, costs that are determined non only by the limited technical margins for emission reduction, but also by the short and medium time scales of the context in which the reduction must be achieved to respect international commitments that have already been undertaken (it should be recalled that the objective established by the Kyoto Protocol must be achieved in the period 2008-2012). These timescales, in fact, significantly counter, in every sense, the current political objectives for the economic development of the country, since they imply the imposition of fines on the industrial sector that could compromise its competitiveness.

The initiatives undertaken by the Ministry of the Environment and Territorial Protection to institute the Italian Carbon Fund at the World Bank, to participate in the Biocarbon Funds and in the Community Development Carbon Fund at the World Bank, and the creation of a fund for the development of CDM Projects in China, again at the World Bank, are not sufficient to ensure that the objective established by the Kyoto Protocol is achieved. To ensure that the Kyoto commitment is respected and contain the cost of reducing emissions, a massive and prompt action needs to be started.

So far as interventions to be undertaken at national level are concerned, the actions that are at present achievable, both for implementation costs and the emission reduction according to the criteria established by the Kyoto Protocol, are on the one hand incentives to create micro-cogeneration plants (these initiatives are, in fact, particularly efficacious, given their short realisation times and their use of modern high energy-efficiency technologies, with indirect benefits in terms of reducing recourse to large electric power transmission networks), and on the other hand, actions to increase CO_2 absorption by strengthening forestation and reforestation activities, forest management and management

of agricultural land, pasture and replanting.

Regions

The relationship between the roles of Central Government and Regions, and the continual search for a balance between them, have constituted an important element in the different energy choices that had to be made at local level during 2004.
A first example concerns the criteria for authorising new electric power stations in the face of a large number of applications. The Conference of Presidents of Regions considered necessary "prior to issuing an order such as the one at issue…. to propose that the Government reopens a round table on the subject of energy (Ministry of Production Activities, Ministry of the Environment, Regions, Electric power Authoritiy and System Operator) with the aim of redefining the forms of institutional cooperation and the regulatory instruments that currently exist". In fact, criteria and procedures that identify some projects as priorities are useful, but only if they are the logical consequence of "close coordination between energy, environmental (and) territorial policies, that takes the role of regional planning into account". Existing ministerial procedures should include a preliminary examination in the light of regional planning laws, and of national energy-environmental policy objectives.
On the other hand, by now over half of the Regions have energy-environmental planning instruments (figure 15). Others are preparing such instruments. Others again have passed or are preparing to pass legislative instruments designed to liberalise energy markets and renew Title Fifth of the Constitution.

Figure 15 - Updated status of energy-environmental plans in the various Regions

Source: ENEA data

Table 13 - Main regional energy efficiency indicators. 2001

	Final energy intensity of GDP (toe/M€ 95)	Electric power intensity of GDP (MWh/M€ 95)	Final consumption per capita (toe)
Piedmont	134.6	283.3	2.8
Valle d'Aosta	149.9	298.0	3.7
Lombardia	116.6	287.6	2.7
Trentino Alto Adige	108.6	244.7	2.6
Veneto	121.5	244.0	2.6
Friuli Venezia Giulia	150.8	368.2	3.1
Liguria	109.3	205.3	2.2
Emilia Romagna	140.3	260.2	3.2
Tuscany	117.6	272.7	2.4
Umbria	152.4	378.3	2.7
The Marches	106.8	245.1	2.0
Latium	94.9	198.3	1.9
Abruzzo	129.2	319.0	2.0
Molise	119.7	281.3	1.7
Campania	96.4	228.1	1.1
Apulia	178.6	324.6	2.2
Basilicata	131.7	317.5	1.7
Calabria	83.0	204.6	0.9
Sicily	114.8	294.8	1.4
Sardinia	147.9	493.1	2.0
Italy	121.1	276.0	2.2

Source: ENEA data processing of data from various sources

So far as the regional energy situation is concerned, a brief overview can be obtained from table 13, which reports the various regional values of several important indicators.

In 2004 another important issue for Ministries and Regions was the revision of decrees on energy efficiency objectives for gas and electric power distribution companies.

These decrees were issued in 2001, creating the system of "energy efficiency shares" (or "white certificates"). But after several problems in applying them the system never got off the ground. So by 2003 the Ministry of Production Activities had already undertaken to modify the decrees.

And here two different overall visions emerged: one related to the government and the Authority, the other to the Regions.

The Ministry of the Environment and the Ministry of Production Activities consider the existence of a single "white certificate" market to be important, and thus support a strictly national system. They also consider that a system of certificates that differs from Region to Region would be difficult to manage.

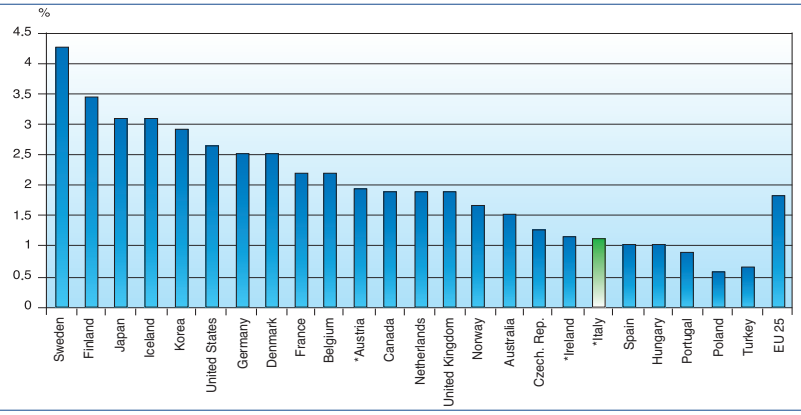
The Regions consider it important to provide guidelines on how to perform energy saving interventions on their territory, requiring an equivalent amount of white certificates.

They do not consider it necessarily a bad thing if a more sectoral or regionalised "white certificate" market develops as a result. What is important for them is that regionalisation of the system must not weaken the overall national objectives, but should, instead, strengthen them.
However, all the institutions involved have shown that they consider it essential for the system to start working as soon as possible. So, to allow interventions related to the white certificates to start, the Regions have finally expressed a positive opinion of the new decrees, which the government had amended to include several measures to correct the territorial imbalance while maintaining the framework of the national Shares system.
The next issue for the Regions and the Government to resolve, on the subject of energy, are the decrees envisaged by Legislative Decree 387/03 on incentives for solar energy and the use of waste for energy generation. Another subject that is sure to further develop during 2005 is the implementation of directive 2002/91/EC on the energy performance of buildings.

Research expenditure

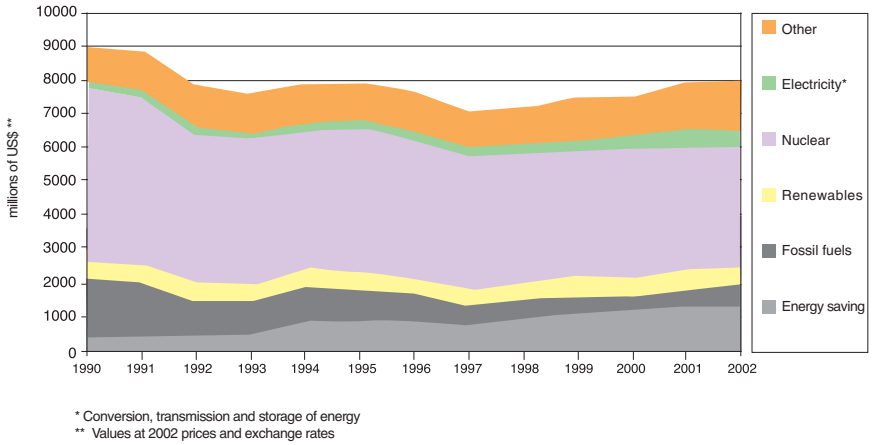
Italy continues to considerably lag behind the other OECD countries in terms of share of the GDP invested in research (figure 16), while in terms of absolute value of expenditure (at purchasing power parity), our country is well below the position it should occupy given the size of its economic-industrial system.
This situation is worrying, particularly if it is taken into account the fact that it is not a transitory phenomenon, but a structural issue, because it is the continuation of a trend that is by now historically consolidated. One of the consequences of the Italian economy's low level of investment in research seems to be the lower growth in terms of

Figure 16 - Comparison of 2002 R&D expenditure of several OECD countries as a proportion of GDP



* 2001 data
Source: OECD data

Figure 17 - Government R&D energy spending in the seven main OECD countries (millions of US$)



* Conversion, transmission and storage of energy
** Values at 2002 prices and exchange rates

Source: ENEA data processing of IEA data

GDP achieved by our production system in recent years.

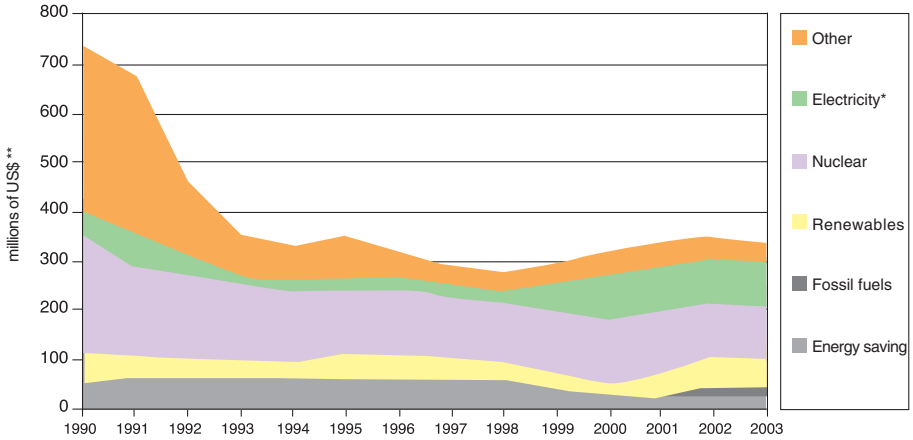
The comparison with some of the most highly industrialised countries in the world highlights Italy's clearly disadvantaged position. Considering the expenditure on R&D as a part of the GDP, Italy is next to last in the ten countries of the OECD, with only Spain behind it, although Spain is rapidly bridging the gap that separates it from Italy. In 2001, with expenditure of 1.1% of GDP on R&D, Italy spent roughly a third of the amount spent by Japan, and well under half of that spent by the United States. This percentage is about half of that spent by France and Germany, the other countries that are our direct competitors in economic and trade terms.

Figure 17 shows the aggregate expenditure on research and development in the energy field by the governments of the main OECD countries (the G7), broken down by technological areas, in the years 1990-2002.

Thanks primarily to the recovery in investments in Japan and the United States, the negative trend seems to have been halted. The graph clearly shows a significant investment in the nuclear sector, even though it is decreasing in relative terms. This result is mainly due to the continual commitment to this industry of the Japanese and French governments, which have maintained their research expenditure levels on nuclear fission almost unchanged. In the remaining countries, apart from Canada, research expenditure on fusion now exceeds that on fission.

Expenditure on technologies for the search, extraction, transformation and transportation of fossil fuels has started to increase slightly in the last year, after a prolonged fall.

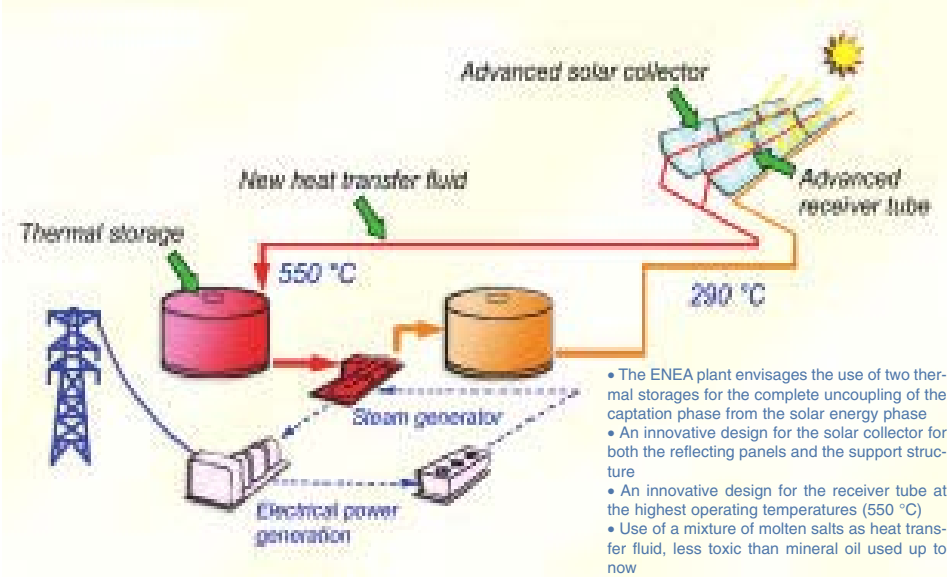
Figure 18 - Government energy R&D spending in Italy



* Conversion, transmission and storage of energy
** Values at 2002 prices and exchange rates

Source: ENEA data processing of IEA data

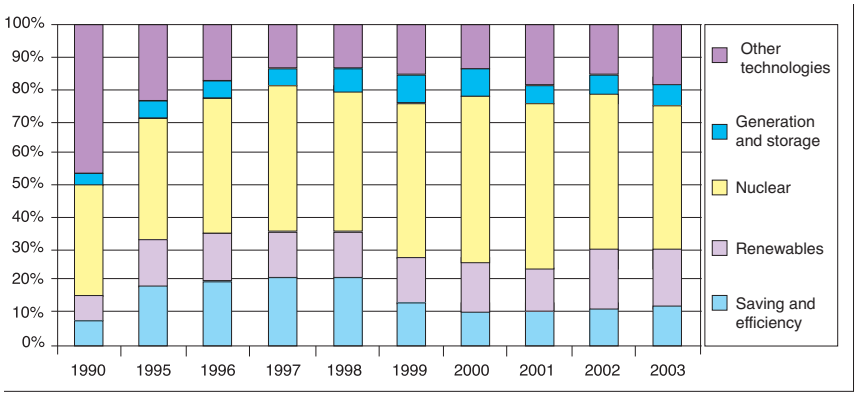
Figure 19 - ENEA's design for a concentrating solar system



- The ENEA plant envisages the use of two thermal storages for the complete uncoupling of the captation phase from the solar energy phase
- An innovative design for the solar collector for both the reflecting panels and the support structure
- An innovative design for the receiver tube at the highest operating temperatures (550 °C)
- Use of a mixture of molten salts as heat transfer fluid, less toxic than mineral oil used up to now

Expenditure on energy saving is gradually increasing.
Research expenditure on technologies for the production, transmission and storage of electric power, and on "horizontal" technologies (other research areas), are also increasing. Research on renewable energy sources is more or less constant, or at most showing very slight growth.
So far as Italy is concerned, figure 18 shows public sector expenditure on research and development in the energy sector from 1990 to 2003. To facilitate comparison with the other industrialised countries, data from IEA sources have been used, expressed in dollars at 2002 prices and exchange rates. As can be seen, the level of expenditure fell to less than half the 1990 level. The fall mainly concerned research on horizontal technologies, or those not specifically classified in any of the other categories, and nuclear research, which increasingly concentrated on thermonuclear fusion, and, for fission, on safety and waste treatment issues. However, research activities on energy saving and efficiency also seem to be falling, concentrating on domestic sector saving and partly on industry, with a parallel abandonment of transport activities.
Public sector research expenditure on technologies for the prospecting, extraction, transportation and refining of hydrocarbons, and for the transformation and combustion of coal, are totally absent, since this sector is essentially a private industry activity (principally oil or electric power companies). Currently, public sector investment is concentrated on nuclear technologies, electric power conversion, transmission and storage technologies, and on renewable energy sources. This latter area is one in which there has been a renewed commitment to research in the last three years, after a prolonged period of stagnation.
The trends noted in the national data are reflected in the data on ENEA research expenditure. However, ENEA's commitment to nuclear fission, connected to its obligations on nuclear safety and waste treatment, has in recent years represented about 20% of the annual expenditure of the body. This continuing commitment is accompanied by our commitment to invest in fusion research, closely linked to our participation in the international ITER project.
The ENEA research budget for both electric power generation and storage technologies and all those hard-to-classify research areas, such as materials or other horizontal technologies has fallen since 1990.
The level of expenditure on renewables seems to have fallen. Here there are some clear trends: maintenance of research expenditure on solar energy and biomasses, and reduction of our commitment to wind power generation. So far as solar energy is concerned, in recent years our research commitment has shifted to thermodynamic solar technologies for the production of electric power (figure 19).
Figure 20 shows the evolution of the mix of energy research undertaken by ENEA in the period 1990-2002.

Figure 20 - ENEA energy R&D spending (%)



Source: ENEA data

Published by ENEA
Communication Unit
Lungotevere Thaon di Revel 76 – 00196 ROME
www.enea.it

Graphic design and printing: Primaprint - Viterbo

Printed in June 2005