Executive Summary
of the Report Energy and the Environment 2005

ENEA - Agency for Sustainable Development - Advisor

The Energy and the Environment Report 2005, prepared by ENEA, is the result of a yearly in-depth analysis of data on the energy situation in Italy, with due references to the international framework, and constitutes a unique and valid tool for reference in this context.
As in the reports of previous years, this Report presents the evolution of the domestic energy situation with reference to energy supply and demand and to environmental issues relating to the energy sector, bearing in mind commitments made by the Government.

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

The 2005 Report consists of two volumes:

- **The analysis,** *reviewing the evolution of the domestic energy and environmental situation over the last year, in the context of global macroeconomics and energy factors;*

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

and this Executive Summary, which gives an abstract of the most significant data presented in the Report.

The Energy and the Environment Report 2005 was drawn up with the partial contribution of the 2000-2006 Community Support Framework, Objective 1, PON-ATAS-FESR, Operational Programme for Energy, Action 1

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The international framework

The expanding global economy

The expansion of global economic activity, favoured by the increase in international trade, continued throughout 2004 but showed an uneven performance in the different geographical areas (Table 1). The pickup in demand in the United States was encouraged by the depreciation of the dollar, the increase in the federal budget deficit, and by the expansive trend of monetary policy that was only dampened slightly during the year. Asian countries (reporting a very favourable trade balance with the USA) maintained their competitiveness and contained the appreciation of their currencies by accumulating monetary reserves in dollars.

Table 1 - GDP and foreign trade. Average annual variation. Years 2003-2004 (%)

	2003			2004		
	GDP	Imports	Exports	GDP	Imports	Exports
Advanced economies	2.0	3.6	2.8	3.4	8.5	8.1
USA	3.0	4.4	1.9	4.4	9.9	8.5
Euro zone	0.5	1.8	0.1	2.0	6.0	5.8
Japan	1.4	3.8	9.1	2.6	8.9	14.4
Newly-industrialised Asian countries	3.0	9.1	12.9	5.5	15.8	17.1
Developing countries	6.4	10.6	10.3	7.2	16.9	13.7
Africa	4.6	6.6	6.6	5.1	9.6	6.9
Asia	8.1	15.1	12.7	8.2	21.5	19.5
Middle East	5.8	3.3	10.1	5.5	8.8	3.8
Latin America	2.2	0.7	3.3	5.7	12.5	10.5
Central and Eastern Europe	4.5	13.5	13.7	6.1	16.0	16.2
Former USSR	7.9	14.5	11.8	8.2	21.1	11.5
World	**4.0**	***4.9**		**5.1**	***9.9**	

Source: ENEA processing on IMF data

*Volume of world trade

Oil price hike

In 2004 the average price of crude oil was close to 38 dollars a barrel, an increase of about 30% over 2003 (Figure 1). The increase did not stop in 2005, and the price of crude oil surpassed 70 dollars in September, also because of the damage to production plants and refineries caused by a series of hurricanes that hit the Gulf of Mexico. The increase in oil prices was affected mainly by the strong demand coming from the most dynamic economies, which created the conditions for a "producer's market", and by the narrowing of unused production capacity margins of OPEC countries. In addition to these causes, the oil-producing countries decided to compensate the loss of purchasing power with higher prices, due to the weakening US dollar. In the long run, the concentration of the remaining reserves in just a few countries in the Middle East favours their increasing market strength. A series of other factors that are sure to persist in the short to medium term sustain prices:

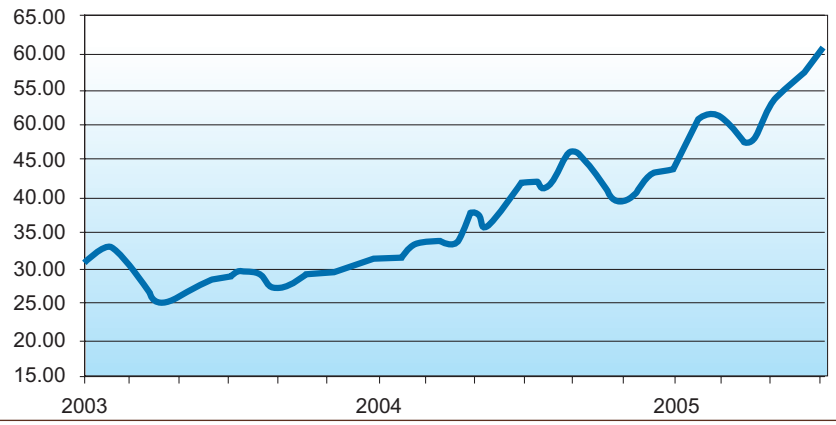
•the failure of the refineries that supply the main OECD markets to adapt plant capacity;

•the continuation of the situation of geopolitical uncertainty in the Middle East, and in other areas of hydrocarbon production in Africa and in Latin America.

Price volatility in 2004-2005 was amplified by particularly responsive speculative movements with respect to contingent factors. Many analysts foresee a price over 60 dollars for most of 2006. These forecasts have the effect of lowering estimated global economic growth, especially in areas most dependent on crude oil imports.

Prices of non-energy raw materials, driven by the demand from China and other Asian countries, also showed significant increases compared to 2003.

Figure 1 - Oil price* from January 2003 to July 2005 (US$/barrel)



* Average between Dubai, Brent and WTI

Source: ENEA processing on DOE and IEA data

Global energy consumption driven by developing countries

In 2004, global consumption of primary energy grew 3.7%. However, the dynamics vary among the world's regions and appear strongly linked to the expansion of economic activity (Table 2). In particular, Chinese energy demand shows a significant progression, with an increase of 12.5%. Increase of consumption in the principal industrialised countries was more moderate due to lower economic growth and to the effect of the hike in energy prices. 2004 was the year energy consumption of developing countries exceeded that one of OECD countries.
In 2004, oil counted for nearly 35.3% of overall primary energy consumption, coal 24.6% and natural gas 20.7%. The remaining 19.4% is made up of primary electrical energy (about 9%, mainly nuclear and hydroelectric), and biomass (about 10.4%.)
During the last months there has been a progressive increase in the relative importance of coal, especially due to the growth of the thermoelectric sector in China and India.

The environment and climate: it will not be easy to honour commitments undertaken

The global environmental scene in 2004 was characterised by a series of intensive negotiations, between the European Union and Russia in particular, in order to permit the coming into force of the Kyoto Protocol, later achieved in January 2005.
The main purpose of parallel negotiations within the EU among member countries, industry and the Commission was to present and approve National Allocation Plans (NAPs) for CO_2 Emissions, a necessary requirement for the application of the directive on Emission Trading. The emissions market opened officially in January 2005, but pending definitive approval of all the allocation plans, the volume of emissions traded and their price have remained very low.
Following the changes to the Italian plan recommended by the Commission, the task of domestic industries looks like being somewhat difficult.

Table 2 - Primary energy consumption by geographical area

	2003	2004	2004	2004/2003
	Mtoe	Mtoe	Share (%)	Variations
Europe	1965.4	1989.6	17.90	1.23
EU (15)	*1525.8*	*1537.1*	*13.83*	*0.74*
EU (25)	*1737.3*	*1752.0*	*15.76*	*0.85*
CIS	969.8	991.1	8.91	2.19
Russia	*660.6*	*675.8*	*6.08*	*2.30*
North America	2554.8	2596.8	23.36	1.64
United States	*2296.4*	*2333.8*	*20.99*	*1.63*
Latin America	640.1	660.5	5.94	3.18
East Asia	2656.5	2873.1	25.84	8.15
China	*1351.1*	*1519.8*	*13.67*	*12.49*
Japan	*513.2*	*523.5*	*4.71*	*2.01*
South Asia	664.0	690.7	6.21	4.02
India	*557.7*	*581.8*	*5.23*	*4.34*
Pacific	133.4	134.6	1.21	0.86
Middle East	455.0	480.8	4.32	5.66
Africa	536.3	548.2	4.93	2.20
North Africa	*128.2*	*132.6*	*1.19*	*3.46*
Sub-Sahara Africa	*408.2*	*415.7*	*3.74*	*1.85*
World	**10721.8**	**11117.7**	**100.00**	**3.69**
OECD	*5415.8*	*5496.3*	*49.44*	*1.49*
OPEC	*748.2*	*783.4*	*7.05*	*4.70*
Former USSR	*988.4*	*1010.6*	*9.09*	*2.24*

Source: ENEA processing on ENERDATA data

The Italian situation

Poor economic growth

In 2004, economic activity in Italy grew at a lower rate compared with other euro-zone economies. As in the previous two-year period, added value grew in the construction and service sectors. Added value in the manufacturing industry is basically stagnant, while the industrial production index fell for the fourth consecutive year.

The extent of the positive contribution of the foreign sector to GDP growth was not significant: the increase in imports (+2.5%), higher than in the rest of the euro-zone was accompanied by an increase in exports (+3.2%) that was not in line with the growth rate of global trade. Consequently, the loss of market share of Italian products continued in 2004, due especially to the structural limits of the country's industrial specialisation model (a sharp drop in exports in the textile, clothing and footwear sectors was registered again in 2004).

A potential scenario

Despite the unpretentious growth in levels of activities and relatively high values in the cost of energy, a potential scenario of the Italian energy system proves an average period trend towards a constant increase in energy consumption (with an average annual growth slightly exceeding 1% up until 2020) and emission levels (in a lower percentage). On a general level, the modest growth in levels of activity will not be accompanied by an improvement in the "structural" characteristics of the system (energy required for each level of activities). In this scenario, on a medium-long term natural gas seems to be destined to replace petrol as the most important main source, until it reaches and exceeds the threshold of 40% of total consumption, while petrol tends to remain stable at a value of between 35% and 40%. The growth in petrol consumption levels in transport will therefore be almost enough to compensate the reduction to a very minimum of its use in power generation (which will follow the strong reduction already registered in industrial and in civil fields). After the very strong growth of the last few years, coal consumption levels will probably remain stable on a short term and then increase, while the weight of renewable sources will increase lightly (always well below 10% of the total).

The most dynamic sectors will the tertiary field, in which the intensity of energy will only start to fall at the end of the next decade, and transport (goods before anything else) due to sustained growth of levels of activities (mobility) and due to the poor and negative contribution towards the reduction in consumption deriving from "structural" factors (means of transport). The sectors with the highest level of consumption growth are therefore the ones that in the past made less use of the margins available to affect activity growth levels and the "structural" factors (in transport) or efficient (in tertiary and residential fields).

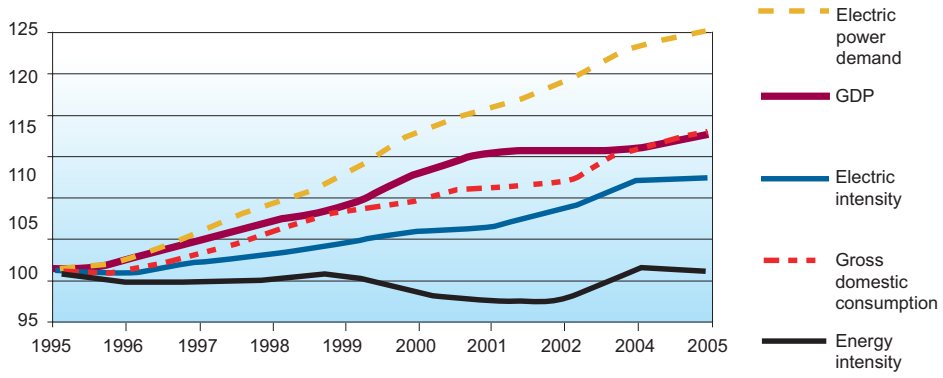
The constant increase in CO_2 emissions from the scenario is due to the fact that the increase in the level of activities is neither compensated by the reduction in energy intensity of the GDP (which, for the following decade, will fall to average annual rates below -0.5%) nor by the reduction in weight of fossil sources and the carbon intensity of fossil energy (rather unpretentious reductions that tend to disappear in the medium term).

In a scenario in which the price of imported petrol is much higher than imagined on the potential scenario (in which prices have remained substantially constant for one decade at approximately $ 50/barrel and subsequently underwent a slight increase), a reduction in the domestic product of between 0.2% and 0.3% would be registered (in line with estimates of recent reports) but it is very difficult that this can lead to an important and long lasting deceleration in energy consumption. Final consumption levels are not very flexible in terms of rigidity of the request for "energy services" (in almost all fields, with the partial exception of industries) and in terms of the growing concentration of petrol consumption levels in transport, where the ability to replace these fuels appears to be limited.

Energy demand: sources and sectors of use

Constant price GDP at the end of 2004 increased 1.2% compared to the previous year. The manufacturing industry went through a period of substantial stagnation during the year and the services sector registered growth in line with the GDP.
Gross internal consumption of energy stood at 196.8 Mtoe, increasing by 1.2% compared to 2003. The increase of energy consumption, comparable to that of the GDP, did not cause any variation in energy intensity values, which stood at 187 toe/M€ (Table 3), confirming the substantial stability of this indicator, which has been recorded since the Nineties (Figure 2). The current trend shows factors of inflexibility of the production system against any further action to reduce energy consumption, after the progress registered in response to the oil shock of the Seventies and Eighties.
After years of relative stability, coal consumption grew by 11.5% in 2004, especially with regard to the increasing use in the thermoelectric sector, reaching 17.1 Mtoe (8.7% of primary energy consumption) in spite of hefty price hikes.
The upward trend in the domestic demand for natural gas (+3.8%) continued and stood at 66.5 Mtoe (34% of primary energy consumption), by virtue of the progressive replacement of obsolete oil-burning thermoelectric plants with new, more efficient turbogas plants.
As a result, overall consumption of oil products equalled 88 Mtoe (45% of primary energy

Figure 2 - Energy intensity and electrical intensity (Index numbers 1995=100)



Source: ENEA processing on MAP data

Table 3 - Primary energy requirements in Italy. Years 2002-2004 (Mtoe)

	2002	2003	2004	2004/2003(%)
Solid fuels	14.2	15.3	17.1	11.5
Natural gas	58.1	64.1	66.5	3.8
Oil products	92.0	90.8	88.0	-3.1
Renewable sources	12.6	13.0	15.2	17.5
Net imports of electric power	11.1	11.2	10.0	-10.5
Total	188.1	194.4	196.8	1.2
Gross Domestic Product ($M€_{1995}$)	1,036,945	1,039,581	1,052,308	1.2
Energy intensity (toe/$M€_{1995}$)	181.4	187.0	187.0	0.0

Source: MAP – National Energy Balance 2004

consumption), falling 3.1% compared to the previous year, in line with the trend registered over the last few years.

In 2004, total demand of electrical energy totalled 325.4 TWh, increasing 1,5% compared to 2003. The increase of electricity consumption, less than the increase registered in previous years, depends mainly on the slowdown of the increase in consumption in the services and industry sectors, and on lower summer temperatures compared to 2003. The increase in electricity consumption, greater than the GDP growth rate, brought about a slight increase in electric intensity (0.2%) that also shows a strong growth trend in the long-term (Figure 2). Final energy uses hiked by 1.3%, passing from 142.2 Mtoe in 2003 to 144.0 Mtoe in 2004, in line with the increase in GDP but with varying performances in the different sectors.

Consumption in the industrial sector grew from 40.9 Mtoe to 41.2 Mtoe (+0.7%), representing 28.6% of final consumption. The increase of consumption in an extended phase of stagnation of production depends mainly on the resilience, in terms of business activity, of sectors with greater energy intensity, and on the simultaneous cutback of sectors with a lower specific consumption, but that represent significant shares of overall industrial output.

Energy consumption in the transport sector, equalling just under 31% of the nationwide total, increased to 44.4 Mtoe (+1.6%). The increase, which was lower compared to previous years, is due to a tendential saturation of traffic levels, especially in road transport. In 2004, the consumption of oil products in the sector shows an increase of 1.6%, due to the increase in diesel fuel in replacement of petrol.

The residential and services sectors covers 30.4% of domestic consumption. Consumption in absolute terms fell from 43.8 Mtoe to 43.7 Mtoe (-0.1%); the reduction is due mainly to climate factors. However, social factors and those linked to the rise in income continue to favour a hike in electricity consumption (greater penetration of household appliances and especially electronic devices and an increase in per-capita living space).

The primary sector contributes for 2.4% of final uses in 2004, with a consumption of 3.4 Mtoe, equalling that one of the previous year.

The supply of energy sources

Oil

In 2004, domestic crude oil production stood at just over 5.4 million tons. This data reflects the increase of production in Basilicata that compensates the rapid decline of the depleting oil fields. Maintaining this only temporary balance depends on the production flow expected from the start of the project to exploit the Tempa Rossa field in Basilicata where substantial reserves have been discovered. 86.9 million tons of crude oil were imported in 2004 (+3.1% compared to 2003), including 82.8 "independently" (+3%) and 4.1 through foreign buyers (5.1%). Russian Ural crude again topped imports in 2004 (over 17 million tons), followed by Iranian Heavy (8 million tons) and by 8 Libyan crudes. The major impact on the energy bill was due to the increase in the oil bill from 15,032 to 16,863 billion euro, an increase of almost 2 billion, despite the fall-off in consumption registered in 2004. The average annual cost of one ton of crude in 2004 was 216.5 euro, against 187.1 euro in 2003. The difference (15.7%) derives from the increased cost of crude (+27.1%) and appreciation of the euro against the dollar.

Natural gas

Production dropped 7.7% compared to 2003, falling to 12.92 billion standard m^3. The producing Regions are Basilicata, Apulia, Sicily, Emilia Romagna, the Marches, Molise and Abruzzo, while, at sea, most production of natural gas comes from Zone A in the Adriatic, which supplies 53.2% of entire domestic production. Overall off-shore production supplies the largest amount (about 82%).
Recoverable gas reserves as of 31 December 2004 total about 178 billion standard m^3, while they were estimated at 370 billion standard m^3 in 1991. The location of almost 70% of current reserves in the sea and, in particular, in Zone A of the Upper Adriatic, makes the problem of the failure to replenish reserves worse.
In 2004, imports increased 8% compared to 2003, covering about 84% of consumption. The division of import volumes according to origin shows that, in 2004, the largest share of imported natural gas comes from Russia through Treviso (TAG pipeline) and Gorizia (36.5% of total flow), while imports from Algeria to the Mazara del Vallo (Sicily) terminal through the TTPC (via Tunisia) and TMPC (in Italian territorial waters) pipelines, represents 35.4% of the total; gas imported mainly from the Netherlands, Norway and other off-shore North Sea producers remained stable at last year's level (24% in 2003).
Liquefied natural gas (LNG) piped to Panigaglia to be regassed and released into the system comes from Algeria as well, and counts for about 3% of imports in 2004. Natural gas imports through the Greenstream pipeline from Libya to the Gela gas terminal began in autumn 2004 and count for about 1% of imports.

As of 1 April 2005, the average domestic benchmark rate is the result of factors covering costs for about 55% and taxes due by the natural gas sector for the remaining 45% (sales tax, regional taxes,VAT). The cost of raw materials affects the total value of the rate for almost one-third (25.7%).

Coal

Italy imports by sea about 99% of all its coal needs, mainly from the United States, South Africa, Australia, Indonesia and Colombia, with significant amounts also coming from Canada, China, Russia and Venezuela. Total imports of solid fossil fuels increased about 16%, rising from 22.1 million tons in 2003 to 25.7 tons in 2004: the largest share came from steaming coal, but coking coal is again on the rise.
The growth trend in the consumption of solid fuels continued in 2004, totalling 17.1 Mtoe (+11.7% compared to 2003), which represents an 8.7% share of domestic energy requirements. In particular, thermoelectric usage showed a significant increase. On the basis of data supplied by the italian National Grid Operator GRTN, over 45.5 billion kWh of solid fuels were produced overall in Italy, with an increase compared to the previous year of about 17% and a consumption exceeding 17 million tons.
2004, like 2003, was again characterised by hefty hikes in international coal prices that even hit $70/t (FOB Italian border) around mid-year, due to both the favourable trend of demand and some production problems.

Electrical energy

The demand for electrical energy on the Italian grid in 2004 was 325,357 GWh, a 1.5% increase compared to the previous year (Table 4). The increase was far below that of 2003, as the level of the economy remained unchanged from the previous year, while air-conditioning systems were used less due to favourable atmospheric conditions.
50.3% of electrical energy was absorbed by the industrial sector, 26.1% by the services sector, 21.9% by the residential and 1.7% by the agricultural sector. 86% of demand was satisfied by domestic production, an increase of 3.2% compared to 2004, and the remaining 14% by the balance between imports and exports, a drop of 10.5% compared to 2003. 16.5% of gross domestic production came from hydric sources, 81.1% from thermal sources and 2.4% from geothermal and renewables. (excluding biomass). The generation of electricity in thermoelectric plants increased by 1.4% compared to 2003, while increase in rainfall in 2004 brought about a 12.7% rise in hydric generation. Net power available installed in December 2004 was 81,512 MW, with an increase of about 3,263 MW (+4.2%) compared to 2003. As for power demand on the grid, a new record was established on 16 December 2004 with a value of 53,606 MW, which was slightly higher than the peak reached in 2003 (+0.4%).

Table 4 - Electric power balance in Italy. Years 2003-2004 (GWh)

	2004	2003	Variation % 2004/03
Gross hydro-electric generation	49,908	44,277	12.7
Gross thermal electric generation	246,125	242,784	1.4
Gross geothermal generation	5,437	5,341	1.8
Gross wind and photovoltaic generation	1,851	1,463	26.5
Total gross generation	**303,321**	**293,865**	**3.2**
Energy for services	13,299	13,682	-2.8
Total net generation	**290,023**	**280,183**	**3.5**
Energy for pumping	10,300	10,492	-1.8
Net generation for consumption	**279,722**	**269,691**	**3.7**
Import	46,426	51,486	-9.8
Export	-791	-518	52.6
Total Italian demand	**325,357**	**320,659**	**1.5**
Losses	20,868	20,870	0.0
Total consumption	**304,490**	**299,789**	**1.6**

Source: GRTN

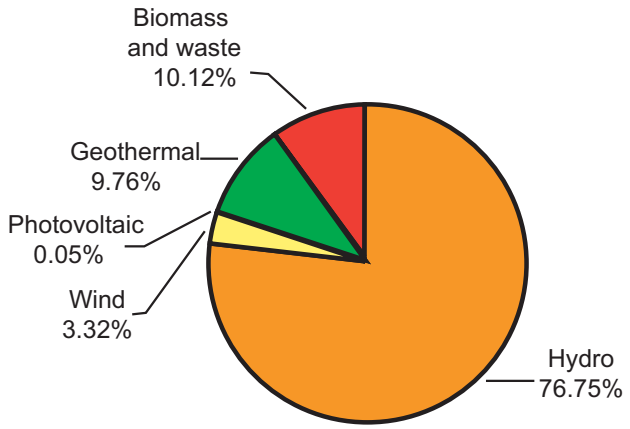
Renewable energy sources

In 2004, renewable energy sources contributed overall to Italian gross domestic consumption with a percentage just over 7%. The total share of all renewables from wind, solar, waste, biofuel, biogas and wood (excluding wood burned for heating) sources increased from just over 14% in 2000 to almost 26% in 2004. Hydroelectric sources, which supply the largest share, are characterised by a fluctuation that can be attributed to hydric availability, while geothermal sources show an increase of about 10% over the entire period. As far as other renewables are concerned, generation from biomass and waste has risen significantly, and 2004 saw an upturn in wind sources after the strong growth registered during 2001 and subsequent slowdown for two years. However, despite the positive trend, the share of these sources remains well below those typical in some European countries.

Electrical energy generation from renewables in 2004 amounted to over 55 TWh, equalling 16% of gross domestic consumption of electrical energy. Compared to 2003, there was an average increase in the generation of electricity from renewables of 16%. Over 75% of generation from renewables comes from hydroelectric sources. Geothermal and biomass (including municipal waste) count for about 10%, wind for

3% and photovoltaic for only 0.05% (Figure 3) The recent legislative decree introducing a new incentive mechanism for photovoltaic energy could help to overcome a long phase of stagnation in the generation of electrical energy from solar sources, even if the fulfilment of the objective of 300 MW of power by 2015 does not appear able alone to significantly modify the amount of electric power generated from solar sources.

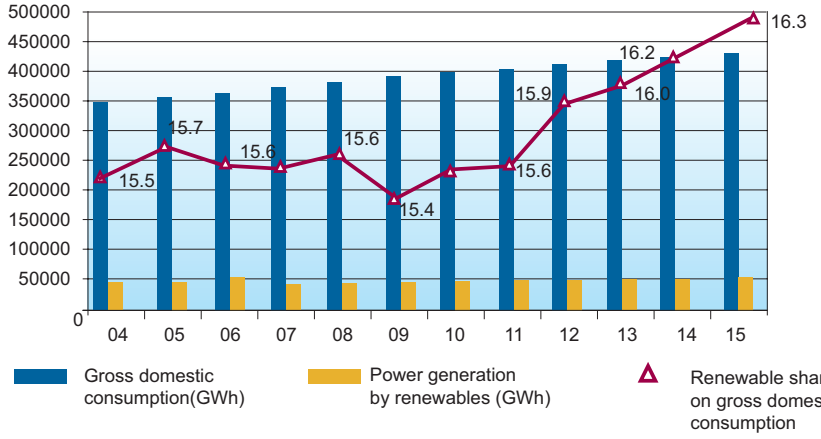
Figure 3 - Share of individual renewables in power generation by renewable sources in Italy. Year 2004



Source: ENEA processing on GRTN data

As far as the production of biofuels is concerned, a replacement of primary energy equalling over 11,700 TJ with an increase near 10% compared to 2003 data was estimated for 2004. The repeal of all taxation on biodiesel heating fuel and the tax incentives granted for fuel blends containing biofuels for the automotive sector contributed greatly to the sector's growth.
All told we are still a long way from a true take-off of renewable energy in Italy, and the incentive mechanisms put in place still do not seem able to enable fulfilment of the target of 22% of gross domestic consumption by 2012 (Figure 4).

Figure 4 - Assessment of the effects of current policies and measures on the national target indicated by Directive 77/2001/EC



Source: ENEA processing on AEEG and GRTN data

Italian rates

The Italian rate system for electrical energy is characterised by lower prices compared to the average European rate for low-consumption domestic use and higher prices for high-consumption users. Prices for industrial use, both gross and net of taxes, are among the highest in Europe, with different variations with respect to the weighted average, according to the consumption level considered. Gross of taxes, the gap is highest (45.9%) in the case of the 2 GWh/year consumption group. Net of taxes, the gap with the average European value is more marked, especially for users with higher energy consumption, because of the lower tax incidence compared to other countries.

The explanation of higher electrical energy prices in Italy is to be found, as well as in the higher tax burden, especially in the low value of average plant efficiency – despite the fact that we are seeing a slow but constant replacement of obsolete plants – and in the mix of fuels, imbalanced towards hydrocarbons that have a high cost per thermal unit supplied. Among the results of the joint survey by the Electricity and Gas Authority and the Italian Monopolies and Mergers Commission, completed at the end of June 2004, is a report criticising the position of the dominant operator as main producer and domestic importer and the negative consequences of these practices on natural gas prices net of tax that, in Italy, remain among the highest, both for industrial uses and major consumer groups, in the European Union.

[1] "Indagine conoscitiva sullo stato di liberalizzazione del settore del gas naturale"- IC/22, Presidenza del Consiglio dei Ministri, Dip.to per l'Informazione e l'Editoria (2005).

Exploration activities

During the last five-year period, expectations for a return on investments in hydrocarbon extraction activities have disappeared into thin air: companies are far more preoccupied with the scarce reliability of timeframes and procedures that come between the discovery of economically extractable resources and their market evaluation than with the exposure to the risk of mining. It's a fact that, at least since 1999, the average time elapsing between the discovery of mineral resources and production can even exceed 11 years, against an average time abroad of 5-6 years. How much this costs the country's economy can be perfunctorily assessed in terms of the negative balance for imports in the balance of payments, and as lost income under the items royalties and taxes.
Despite the sharp increases that have taken place over the last two years, coal is still considered the most suitable source for electrical power, as the increases have not significantly affected the final price of electrical energy, since most supplies are governed by long-term supply contracts signed before the recent price hikes. However, in the medium to long-term view, it is undeniable that the competitiveness of coal will need to be compared with future scenarios, outlined, on the one hand, by the National Allocation Plan for greenhouse gas emissions quotas, in accordance with Directive 2003/87/EC and, on the other, by commitments deriving from the Kyoto Protocol, with related specific costs associated with carbon dioxide emissions.

The energy system and the environment

Emissions

Data processing shows that emissions of traditional air pollutants (not greenhouse gases) due to energy systems continue to decline despite an increase in consumption. This is due to an ever-increasing proliferation of systems capable of reducing emissions of air pollutants, and to the use of "cleaner" fuels. The increase in energy consumption is due mainly to the rise in electrical energy consumption and, in particular, to the rise in the summer peak, due especially to civil uses, which upsets optimisation of plant functioning.
On the other hand, as far as CO_2 is concerned, we are faced with an increase in emissions (Table 5 and Figure 5), which is also due to the increase in electrical power consumption. This compromises actions necessary to respect the commitments laid down by the Kyoto Protocol. The National Allocation Plan (NAP) for the exchange of greenhouse gas emission quotas is also facing considerable problems in this respect.

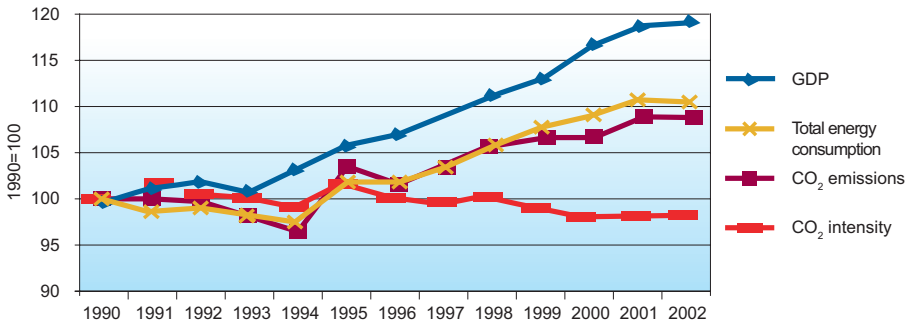
[2]In 2004, overall royalties (product rates) paid to the central government, Regions and Municipalities by concessionaries for oil and natural gas production acitivites carried out in 2003, totalled 146.9 million euros.

Table 5 - Greenhouse gases emissions from macro sectors. Years 1990 and 2002 (millions of t of CO_2 eq.)

	CO_2		N_2O		CH_4		F-gas	
Years	1990	2002	1990	2002	1990	2002	1990	2002
Energy industries	135.86	155.07	1.67	1.90	7.10	5.54	0.00	0.00
Manufacturing industries	87.85	84.94	1.63	1.65	0.14	0.14	0.00	0.00
Transport	102.90	125.26	1.79	3.66	0.78	0.65	0.00	0.00
Residential and services	76.12	77.76	3.44	3.18	0.32	0.49	0.00	0.00
Industrial processes	26.15	24.41	5.81	7.47	0.12	0.12	2.49	8.28
Use of solvents	1.73	1.24	0.00	0.00	0.00	0.00	0.00	0.00
Agriculture	0.00	0.00	22.76	23.16	17.78	16.56	0.00	0.00
Waste	0.54	0.28	1.13	1.18	10.95	10.85	0.00	0.00
Total	431.16	468.96	38.23	42.20	37.20	34.34	2.49	8.28

Source: ENEA-APAT. 2004

Figure 5 - Comparisons of the main economic and energy indicators and CO_2 emissions (1990=100)



Source: ENEA-APAT-Min. Environment, 2004

Plants

The new plants approved (Figure 6), for 80% with fossil fuels (combined cycle with natural gas), are unequally distributed around the country, and this creates conflicts and realisation problems.

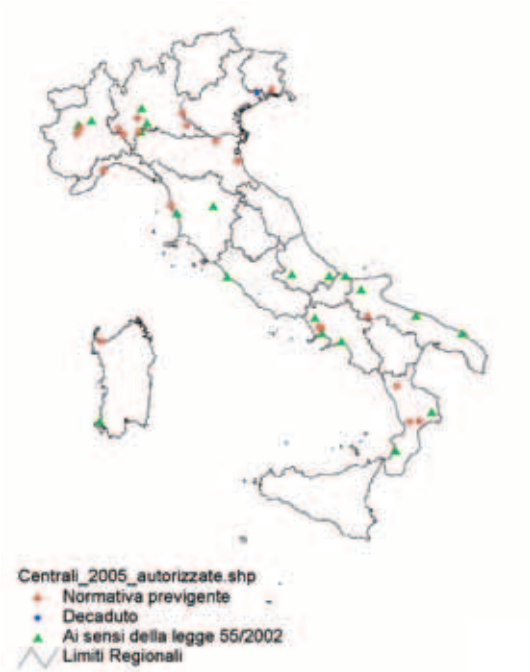
The generation of electrical energy remains a critical aspect of the entire system: Law 55/2002 speeded up procedures for the construction of new electricity plants, declaring power plants over 300 MW works of public utility and only subject to approval by the Ministry of Productive Activities (Municipalities are consulted as part of the procedure) within 180 days. 43 START permits were issued as of July 2005 for a total of about 21,000 MW of electric power. Work has begun for the supply of 10,000 MW. Between divestments and new plants, it is estimated that about 6-7,000 MW will be added on the domestic market, but another 73 requests for approval for about 38,000 MW are still pending. This data shows a production effort that is also aiming at an increase in efficiency (fewer emissions per kWh produced), but insufficient to counterbalance the increase in demand with the environmental aspect.

The industry shows a reduction in consumption and emissions, both due to the use of new technologies and for the effect of delocalisation and the economic crisis.

In the transport sector, the demand for mobility remains as a whole on the upturn, accompanied by experiments with new technologies: low-emission fuels (methane and LPG) and replacement of transportation vehicles (small and large).

The residential sector is characterised by the increase of summer consumption (more than 2 million new air conditioner installations per year are estimated) and by the growth of building construction.

Figure 6 - Distribution of new, approved natural gas combined cycle plants



Source: ENEA processing on MATT and MAP data, 2005

Energy saving

There are various ways to intervene for the purpose of achieving energy saving in the Energy, Industry, Transport and Civil sectors. A description of actions to be taken in the short to medium term are provided below.

Energy: concentration will be on building trigeneration plants (electrical energy, heating storage and cooling storage), giving priority at the same time to projects for rapid realisation with a good cost/benefit ratio, such as the increase in efficiency of the distribution network, which alone is capable of helping to optimise NAP reserve quotas with a potential savings estimated at about 11,000 MW.

Industry: companies or small producers require independently managed cogeneration systems. The demand for new materials for use in small plants operating in aggressive environments is also strong.

Transport: there is clearly an "emergency situation" in urban centres caused by traffic, while freight transport, which is tied to the production network's sprawling distribution system and to third-party logistics, ends up by increasing costs, consumption and, consequently, emissions.
Possible actions in this respect concern applying systems such as Strategic Environmental Assessment (SEA), necessary for optimising traffic flow and vehicles.

Building and municipal construction: starting in 2006, all new constructions must be built according to "consumption and energy dispersion" coefficients provided in European Directive 20052/91/EC.
This measure, in consideration of the old age of the Italian architectural heritage, is undoubtedly the best for its cost to benefit ratio, and it can also be easily applied, since the technologies for intervention are already available.

Energy and environmental policies at the regional and local level

The role and jurisdiction of the Regions in energy matters have become very important after the introduction of Leg. Decree 112/98 on decentralisation and subsequent legislation by the Regions on the subject, including authorisations to the Provinces. The Regions can draw up and discuss their own Regional Energy Plans. The Central government remains responsible for decisions concerning energy policy guidelines and the co-ordination of regional energy programmes.
The analysis of the regional energy situation (production, transformation and final energy consumption by source and by sector) is carried out according to Regional Energy

Reports compiled by ENEA for the last 15 years, in consistency with National and European Energy Reports.
Energy indicators drafted later (intensity and specific consumption) show an increase of values at the regional level in 2003 compared to previous years, inverting the downward trend of previous years. There are also considerable differences among Regions because of differences in economic growth and for the presence of energy-greedy industries in the country (Table 6).

Table 6 - Main regional energy efficiency indicators. Year 2003

Regions	Final energy intensity of GDP (toe/M euro95)	Electric power intensity of GDP (MWh/M euro95)	Energy cons. per capita toe/ab	Electric power cons. per capita (MWh/ab)
Piedmont	140.3	300.6	2.9	6.2
Aosta Valley	177.4	328.3	4.2	7.7
Lombardy	121.4	301.4	2.7	6.8
Trentino Alto Adige	108.1	267.1	2.5	6.2
Veneto	128.1	311.8	2.6	6.3
Friuli Venezia Giulia	153.8	381.6	3.2	7.9
Liguria	104.4	205.6	2.1	4.1
Emilia Romagna	150.1	282.0	3.4	6.3
Tuscany	125.3	289.4	2.5	5.7
Umbria	159.0	383.3	2.7	6.5
The Marches	117.3	265.4	2.1	4.7
Lazio	99.7	201.9	2.0	4.1
Abruzzo	144.7	331.6	2.2	5.1
Molise	127.9	311.4	1.8	4.5
Campania	95.8	234.7	1.1	2.8
Apulia	179.8	336.7	2.2	4.1
Basilicata	124.3	341.1	1.6	4.4
Calabria	87.5	215.2	1.0	2.5
Sicily	111.7	294.7	1.4	3.7
Sardinia	163.0	510.5	2.2	7.0
Italy*	**125.8**	**288.4**	**2.3**	**5.2**

* *contains the extra-Region GDP*
Source: ENEA processing on data from various sources

Environmental indicators of regional energy systems, in particular for CO_2, show an upturn trend of values, which contrast with the pursuit of the objectives of Kyoto. In particular, CO_2 values from thermoelectric generation are on the rise.
Without the National Energy Plan, Regional Energy Plans (REPs) are the instruments for strategy and programming for the entire National Energy System.
Nearly all the Regions have defined their Regional Energy Plan: thirteen of them have wei-

ghed the pros and cons in the Regional Board or Council, and they were joined by the two Autonomous Provinces of Trento and Bolzano. Other Regions have drafted Plan Analyses that have been formally approved.
The objectives of the REPs approved can be summarised as follows:
•Development of renewable sources. Production of electrical energy for 17,000-19,000 GWh, in addition to thermal energy.
•Development of energy saving: for a total of about 15,000 ktoe, estimated for all regions. In terms of emissions, this would cut about 60 mt of CO_2 that make up 60% of CO_2 emissions to be cut with respect to the trend for 2012 to fulfil the objectives of Kyoto. The difference of 40 Mt could be obtained by the emissions market and international programmes.

Table 7 - Status of the Regional Plans for Energy and the Environment (June 2005)

Region/Autonomous Province	State of implementation
Aosta Valley	Resolution adopted by the Regional Council in 2003
Piedmont*	Adopted by the Regional Board in 2002
Lombardy*	Adopted by the Regional Board in 2003
Trento	Adopted by the Provincial Board in 2003
Bolzano	Adopted by the Provincial Board in 1997
Veneto*	Adopted by the Regional Board in January 2005
Friuli Venezia Giulia	Plan draft drawn up in 2003
Liguria*	Adopted by the Regional Board in 2004
Emilia Romagna*	Adopted by the Regional Board in 2002
Tuscany*	Adopted by the Regional Council in 2000
Umbria*	Adopted by the Regional Council in 2004
The Marches	Adopted by the Regional Council in February 2005
Lazio*	Adopted by the Regional Council in 2001
Abruzzo*	Plan draft drawn up in 2003
Molise*	At definition phase
Campania*	At definition phase
Apulia*	At definition phase
Basilicata*	Adopted by the Regional Board in 2000
Calabria*	Adopted by the Regional Board in 2002
Sicily*	At design phase
Sardinia*	Updated and adopted by the Regional Board in 2003

(*) Regions where ENEA has provided or is providing support
Source: ENEA processing of regional data

The Regions have approved plants supplied by renewable sources, qualified by the GRTN on 31/05/04, for a total of 4,894.6 MW with an overall productivity of 12,060 GWh/year and an increase of 25.1% over 2003. Most of these are wind power plants (9,970 GWh/year), but there are also hydroelectric, geothermal and biomass plants and a residual share of photovoltaic systems. The increase in wind power plants is significant, especially in the Regions of the South, in particular Molise, Apulia, Calabria, Sicily, Sardinia but also the Marches.

The most important projects for electrical energy generation plants, approved by the Regions and qualified by the GRTN as new or reactivated, are the following (productivity in GWh is in parentheses, MW capacity on the right):

The Marches:	Hydro (2.2); Wind (629); Waste and Biomass (8.2).	261.8
Molise:	Wind (492.4); Waste and Biomass (2.8).	214.8
Campania:	Hydro (1.8); Wind (371,2); Waste and Biomass (88).	148.9
Apulia:	Wind (2,029).	833.5
Basilicata:	Hydro (4.5); Wind (456.3).	198.0
Calabria:	Hydro (14.7); Wind (1179.6); Waste and Biomass (282.8).	604.6
Sicily:	Wind (3,539); Waste and Biomass (22).	1,371.5
Sardinia:	Wind (1,104.4); Waste and Biomass (6.3).	467.4

Domestic incentivation programmes of the Ministries of Productive Activities and the Environment provide significant financial support and regulations for the Regions' activities in the energy sector. In particular, for photovoltaic and solar thermal plants, financing has now been transferred from the Environment Ministry to the Regions which have made their calls for bids. The summary of the interventions shows that all the Regions have activated administrative procedures for providing incentives for energy saving and renewable sources.

Structural Funds within the Community Support Framework (CSF) concerning the subject of energy, for Objectives 1, 2 and 3, are an important opportunity for financing regional projects. The National Operational Programme, Technical Assistance and Systems Action (NOP TASA) includes three interventions; the first (Project Support and Energy Plan Implementation) is divided into three parts and conducted by ENEA.

With regard to interventions in the energy sector planned by the ROPs for Objective 1, there are substantial financial resources (EU, governmental and regional) available for the measures chosen by the Regions concerned (Tables 8-10).

Table 8 - Financial Plan of Measure 1.2 of the NOP-TASA

Region	Total cost (M€)	Governmental resources (M€)	EU resources (M€)	Implementing parties resources (M€)	Structural fund participation rate
Action 1	2.79	0.70	2.09	0.21	75%
Action 2	2.79	0.70	2.09	0.21	75%
Action 3	0.42	0.10	0.31	0.03	75%
TOTAL	6.00	1.50	4.50	0.45	75%

Table 9 - Financial data of measures in the energy field contained in the ROP of Objective 1

Region	Measure	Total cost (M€)	Total public resources (M€)	EU resources (M€)	Government resources (M€)	Regional resources (M€)	Private contributions (M€)	Structural fund participation rate
Basilicata	1.6	24.6	24.6	12.3	12.3	0	0	50%
Calabria	1.11	71.2	71.2	35.6	34.2	1.4	0	50%
Campania	1.12	245.1	245.1	122.6	122.6	36.8	0	50%
Molise	1.8	7.2	7.2	3.1	2.9	1.2	0	43%
Apulia	1.9	43	43	21.5	15	6.5	0	50%
Sardinia	1.6	21.9	21.9	10.9	7.7	3.3	0	50%
Sicily	1.16	125	125	56.2	48.1	20.6	0	45%
Sicily	1.17	127.2	127.2	57.2	49	21	0	45%

The data given in the table does not take into account financial resources set aside for energy recovery of waste. as they are unavailable.

Table 10 - Financial data of the measures in the energy field contained in the DOCUP* of Objective 2

Region	Measure	Total cost (M€)	Total public resources (M€)	EU resources (M€)	Government resources (M€)	Regional resources (M€)	Other public-institutions (M€)	Private contributions (M€)	Structural fund participation rate
Friuli*	3.1.2								
Liguria	2.3	6.4	6.4	1.9	2.1	1.1	1.3	0	30%
Tuscany	3.1	4.8	4.8	1.7	1.4	1.7	0	0	35%
Tuscany	3.2	21.4	21.4	7.4	6.6	7.4	0	0	35%
Lombardy	3.4	20.3	20.3	10.1	7.1	3.0	0	0	50%
Veneto	2.2	19.1	19.1	9.6	6.7	2.9	0	0	50%
Trento	2.2	6.1	5.1	1.5	2.5	1.1**	0	1.0	25%
Lazio	1.3	10.3	10.3	5.1	3.6	1.0	0.3	0.5	50%

Data relating to measure 3.1 is available. but not for Action 3.1.2
*DOCUP= Single Document of planning drawn up by the Regions

The evolution of energy technologies

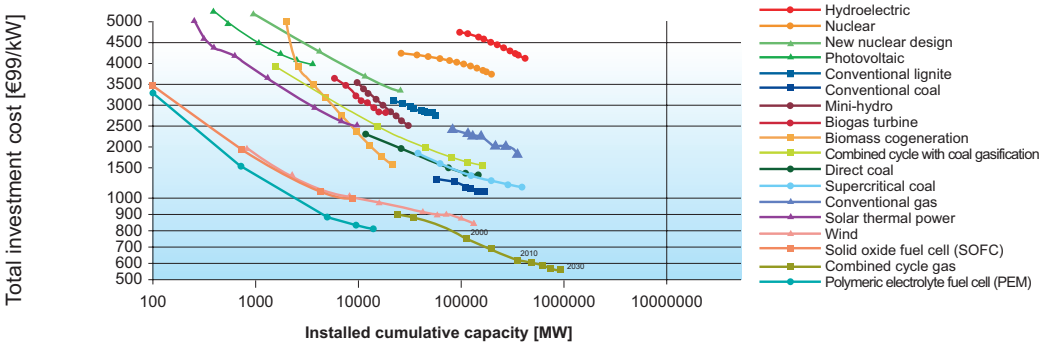
The development of advanced systems and cycles for energy production, with characteristics that are very promising in terms of performance, emissions control and flexibility in the use of fuels, is an important opportunity for the country's technological development, capable of relaunching competitiveness in the country's supply system of technologies in the sector and of bringing together the skills and efforts of the various players concerned,

guaranteeing at the same time continuity in investments already granted in previous years. The Italian industrial system has all the necessary skills and resources in its advanced energy plant engineering capability. However, Italy appears behind in its commitment to research in the most innovative energy technologies. The structural tendency in the medium to long term to high prices for oil products, and the increasing dependency on foreign energy supplies, which concerns the entire European Union and in particular Italy, calls for setting up significant research and development projects in the sector of energy technologies to face up to the challenge of improving plant performance, to be achieved with a drastic reduction of emissions into the atmosphere. In addition to price and fuel availability, the development of energy technologies plays a crucial role in the planning of the future energy system.

It is useful to remember that predicting the development of technologies is a difficult activity that sometimes produces results that can be interpreted in different way, especially when the temporal reference horizon moves in the long term. On the other hand it is also true to say that in the last few years remarkable progress has been made in the ability to model the development of technologies within energy models. As part of the EU programme WETO, experience curves (taking into account the "learning by doing" effect) for several technologies in the development phase were reconstructed on the basis of past data up to 2000 and forecasts to 2030 of a benchmark scenario.

The learning curves that describe the trend of total investment costs in the various technologies according to total capacities installed are shown in Figure 7 with reference to time steps of five-years. But, as we know, rapid technological developments and real tech-

Figure 7 - Electrical energy generation costs from various technologies according to installed power



Source: WETO, 2003

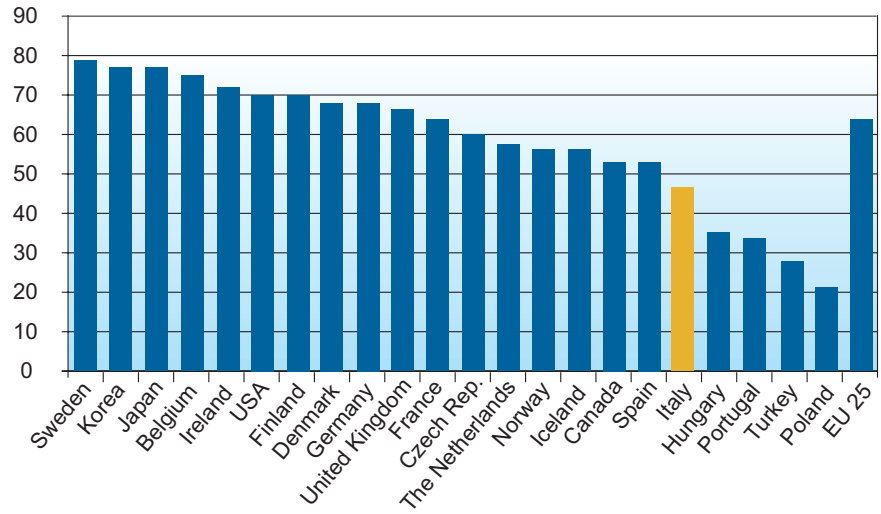
[3] World Energy, Technology and Climate Policy Outlook (WETO), European Commission (2003).

nological breakthroughs can determine deviations in the course of events described according to the benchmark scenario. In this respect, alternative theories with regard to several "technological cases" were drafted, again at the WETO level, in which the speeding up of investments in R&D activities assumes a special importance.
In particular, in the "natural gas case", an increase in availability of the source along with additional technological improvements in combined cycle gas turbine plants and fuel cells is assumed; for the "coal case", significant improvements in the performance of all innovative solid fuel combustion technologies; and for the "nuclear case", a "hike" in technology in terms of cost and safety. This assumption undoubtedly influences the trend of the curve regarding large conventional light water reactors but, above all, it is important for the most innovative reactors.
The "renewables case" foresees a stronger commitment of the international community in terms of incentives and financing for research, aimed in particular at the development of wind, thermodynamic, photovoltaic and small hydroelectric plants. Confronted with a significant reduction of unitary investment costs, this commitment could bring about an increase of electrical energy generation and averted CO_2 emissions.

The innovative system and technological competitiveness of Italy in an international context

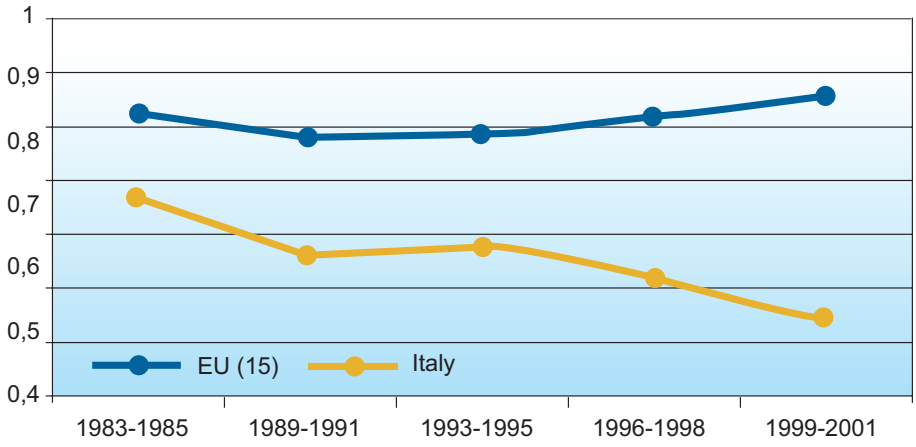
Over the last few years, innovative systems in Italy appear marked by a progressive regression, also with regard to recent developments in some Eastern European economies. In particular, the growth of spending intensity in research compared to the GDP in the major industrialised countries appeared very dynamic, with ratios varying between 2 and 3%, whereas Italy's position in 2002 (last available year) was 1.16%. The Italian anomaly surfaces blatantly with regard to the share of business enterprise expenditure on R&D, just over 48% in 2002, against an average of 63% in the "enlarged" EU of 25 countries (Figure 8). The ratio between the world share of hight-tech patents and the world share of total patens also shows (Figure 9) a growing gap between the value registered for Italy and that for the EU-15 (the first drops from 63% in 1993-1995 to 51% in 1999-2001, the second rises from 81% to 88% over the same period.
The limited importance of the production system in advanced technology sectors, and the concurrent "dwarfism" of companies condition the meagre share of company spending in R&D, contributing to delaying the fulfilment of the "Lisbon objectives". Recent assessments have highlighted the substantial comparability between spending in R&D by the Italian production system with that of the major European countries such as France and Germany, if the differences in dimensional structure and specialisation in production is taken into account.
The critical structural conditions characteristic of the production system combine with those relevant to the scientific system and are marked by a series of indicators: the ratio between public and private researchers in Italy is 1.51, while for the EU at 15 it is 1.03, for Japan 0.48 and for the USA 0.17; the difficulty for young people to enter the scientific establishment; the drop in university students enrolled in scientific fields; research edu-

Figure 8 - Business enterprise expenditure on total R&D. Year 2002 (%)



Source: ENEA High-tech Observatory. Processing of OECD data

Figure 9 - Italy and EU (15): ratio between the world share of high-tech patents and the world share of total patents



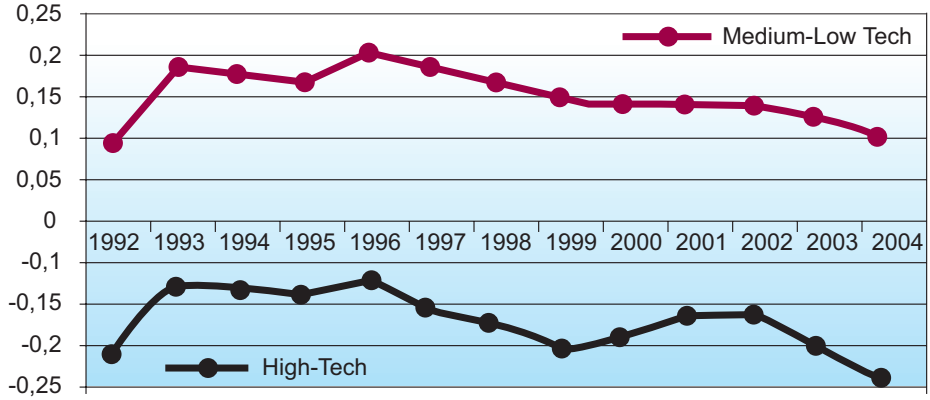
Source: ENEA High-Tech Observatory. Processing on Cespri data

cation through research doctorates, which do not show a clear discontinuity with regard to primary university education in the services sector also due to the difficulty PhD holders have in finding suitable positions in the labour market; the negative balance with foreign countries in the flow of researchers.

On the other hand, the most recent developments in the process of globalisation underway show not only an ever-increasing pre-eminence of technological dynamics, but also the emergence of a much more complex world scenario, which makes Italy's deterioration in competitiveness more problematic. Alongside the major industrialised economies, the increase of new economic players is characterised by the boost in the spread of innovative processes, often driven by new and important flows of foreign direct investments and by the emergence of significant changes in the international market of high-tech products.

Therefore, the sharp deterioration of the trade deficit registered by Italy in this area during the 2003-2004 period (Figure 10), despite production stagnation that curbed imports, and the upturn in the international economy that reached a development rate rarely seen in the past, which should have increased exports, appears worrisome. Similar but not as marked behaviour also concerned medium-low tech production, with a loss of competitiveness that cannot be considered, in any case, less relevant than that registered by high-tech, because of the interactions and technological interdependencies that characterise every production system. Various factors related to the current economic situation have

Figure 10 - Italy: normalized trade balances



Source: ENEA High-Tech Observatory. Processing on ISTAT data

thus accompanied the deterioration of a system of technological competitiveness increasingly weak and in its capacity to generate innovation.
The responsive strategy to this critical condition, which the new National Research Programme 2005-2007 has attempted to address, outlines a new procedure of financial support for R&D activity that calls for close cooperation between the various players, universities, public research organisations and industry in support of programmes in crucial sectors for the economy and industry.
Data emerging from the 2001-2003 Report of the Committee for evaluation of government research indicate that research activity by the organisations is generally of good quality and with a high degree of internationalisation, also reaching peaks of real excellence. Obvious critical factors remain concerning the impact and capacity to transfer knowledge and technologies; educational activity shows scarce foresight in satisfying the needs of the production and services sector, and a shortcoming common to practically all the organisations is the benchmarking of resources and results with comparable extra national organisations. And finally, the current lack of financial resources precludes an effective impact of public support for industrial research provided by legislative decree 297/99.

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