Mediterranean and National Strategies for Sustainable Development
Priority Field of Action 2: Energy and Climate Change

Energy Efficiency and Renewable Energy
Italy - National study

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Energy and Sustainable Development in the Mediterranean

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Italian National Study Report

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Updated: March 2007

Introduction

This document was prepared in the framework of the Mediterranean Strategy for Sustainable Development (MSSD) follow up and is intended to set a basis for discussion in the workshop “Energy and Sustainable Development in the Mediterranean”.

A brief overview is given to current RUE (Rational Use of Energy) and RE (Renewable Energy) strategies and policies in Italy, with an insight to existing data and forecasted evolutions. Institutional specificities, impacts and risks, as well as financing and investment needs are highlighted. Some case studies of successful projects in the field of energy technologies are also presented.

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SUMMARY

Abstract

Italian priorities in the energy field are strictly related to the main issues of securing energy supply, reducing GHGs and pollutant emissions and assuring competitiveness in the energy sector. To this end, renewable energies and energy efficiency represent the key tools able to address simultaneously all the above mentioned topics.
In this field, the main targets are the 6,5% GHGs reduction with respect to 1990 levels under the Kyoto Protocol and the national indicative objective of 22% of electricity from renewable energy sources in the gross electricity consumption in 2010 under the EU Directive 2001/77/CE.

Total primary energy supply will increase in the next years, but the policies adopted to promote renewable energy and energy efficiency will lead to a constant slow decrease of energy intensity. Anyway, Italy will remain dependent on fossil resources in the next future and, consequently, strongly dependent on external resources (almost 91% of natural gas and 93% of oil are expected to be imported in 2020).

Renewable energy will continue to increase in time, above all in the electricity sector. The 2005 renewable energy electricity gross production (almost 50 TWh) represented 16,4 % of total gross production, 15,1 % of total electricity demand (net consumption + network losses = 330,4 TWh) and 14,1% of gross inland consumption (352,8 TWh). This last percentage rises to 17,3% if we consider the importation of electricity from renewable energy sources certified through the Guarantee of Origin.
The main tool to support renewables will remain the “Green certificate” market-based mechanism. In parallel, the feed-in tariff scheme for photovoltaic and the recent legislation on energy efficiency in the building sector will contribute to accelerate the increase of renewables in the energy mix.

Another market-based mechanism named “White Certificates”, is also used to support energy efficiency and energy saving measures to reduce consumption to the end-use. The aim is to achieve, by the end of the five-year period 2005-2009, a total energy saving of 2.9 million tep.

In terms of policy priorities, the building sector has been considered a relevant sector in which it is crucial to intervene to reduce energy consumption and related emissions. Among several standards, conditions and modalities to improve the energetic performance of buildings, the recent legislation (Legislative Decree 29th December 2006, n.311) foresees also that in all new buildings, or in case of restoration of existing thermal plants, at least 50% of the annual primary energy necessary to produce hot sanitary water should be provided using renewable energy sources. This limit is reduced to 20% for buildings located in historical centres.
For new buildings, or in case of restoration, it is foreseen the obligation to install photovoltaic for electricity production with a power capacity to be defined in a ministerial decree.
Furthermore, for new buildings, or in case of restoration, it is obligatory to foresee the setting of all necessary works related to the connection to the district heating network, if this is located nearby.

Energy saving and renewable energy are also boosted through specific fiscal and administrative measures, generally introduced each year with the Financial Law, such as:

- deduction from taxes of a certain % of total cost of the interventions devoted to the increase of the efficiency or to the installation of renewable energy equipments;
- reduced taxation (such as VAT) for clean technology equipments and systems
- reduction/rationalization of administrative procedures and costs

Capital incentives are also available, but the adoption of market-based mechanisms at national level leave them mainly as regional and local measures.

In order to favour measures to reduce GHGs emissions from energy sources, a Rotation Fund, with a size of 200 M€ for each year from 2007 to 2009, has been established to support a number of priority actions such as "high-performance distributed micro-cogeneration plants for electricity and heat generation" and other interventions (including pilot projects) utilizing renewable energies.

Italy is also very active in promoting renewable energy and energy efficiency at the international level through the implementation of cooperation projects and programmes. Among multilateral activities, a special mention has to be made on the active involvement in the field of renewable energies: in 2002 Italy launched the Type II Initiative “Mediterranean Renewable Energy Programme (MEDREP)” with the aim to promote renewable energies in the Mediterranean region and in 2006 the international partnership on Bioenergy (GBEP) with the aim to promote a sustainable use of biomass and biofuels.

Furthermore, Italy is carrying out a relevant bilateral cooperation on sustainable energy with China, Balkan countries and USA, mainly devoted to research and development on clean and innovative energy technologies and applications.

As for the Mediterranean Region, Italy is further committed in increasing neighbourhood cooperation to improve regional energy infrastructures, such as the electrical interconnections North-South, that are crucial means to improve security in the electrical system.

As regards the awareness raising in the field of sustainable energy, several activities and programmes, such as the “National System on Environmental Information, Training and Education (INFEA)” have been implemented at national and local level. Among the most recent activities in this field, the Italian Ministry for the Environment Land and Sea is associated to the European Commission for the implementation of the Sustainable Energy Europe (SEE) Campaign in Italy. The aim is to raise public awareness and promote sustainable energy production and use among individuals and organisations, private companies and public authorities, professional and energy agencies, industry associations and NGOs across Europe.

I. THE COUNTRY'S ENERGY SITUATION: INDICATORS AND BASIC DATA

1.1 Share of the Energy Sector and Institutional Specificities

The Italian energy policy is currently based on market liberalisation, diversification of energy sources, transfer of powers to the regional authorities, energy security, energy efficiency and environmental protection.
The energy mix is characterised by a substantial reliance on oil and gas. Gas utilisation is gradually increasing with respect to oil. As for renewable energies, although hydro still represents the main source, wind, solar and biomass are registering a significant growth. The nuclear energy option was abandoned in 1987, following a national referendum.
Relevant progress has been recently made in implementing electricity and gas market reforms and restructuring the energy industry. Important objectives have been accomplished by transposing into legislation the EU directives for electricity and gas market liberalisation. Large state-owned energy companies started to be privatised and new institutions established.

In 2005 gross internal consumption of energy amounted to 197,78 Mtoe. The following graph shows its trend over the last years, which registered an increase comparable to that of the GDP, thus not affecting energy intensity values (187 toe / M€ in 2004), confirming the substantial stability of this indicator. The low energy intensity values are due to a high degree of energy efficiency, but also to the economic environment and the high electricity prices. Energy intensity values are expected to further decrease in the next decades.

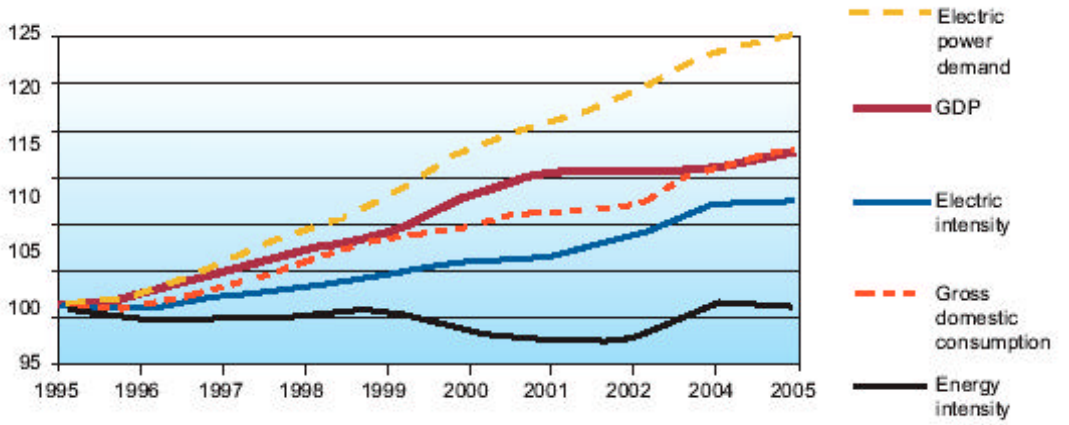


Figure 1: Energy Intensity and Electrical Intensity vs. GDP, Gross Domestic Consumption and Electric Power Demand (Index Numbers: 1995=100) (source: ENEA: Report Energy and Environment 2005)

Italy's energy system remains substantially dependent on imports. In fact, although oil and gas geological reserves have the potential to increase the domestic production, demand largely exceeds potential supply. Yet, with the largest refining industry in Europe (17 refineries), Italy has a significant export of oil products, mainly for central and Eastern Europe.

The Italian gas pipeline network is well developed, although new infrastructure is necessary to satisfy the current trend of growth in gas demand. The transportation network includes 17.000 km of high pressure pipelines and the distribution grid is nearly 200.000 km long.

Italy has three entry points for gas imports: the Transmed pipeline, importing Algerian gas through Tunisia; the TAG pipeline, connecting to Austria and importing Russian gas through Ukraine and Slovakia); the TENP and Transitgas pipelines through Switzerland, importing Dutch gas via Germany and Norwegian gas via France.

The Electricity network is made up as follows (2005 data):

400 kV	216,5 km
380 kV lines	10528 km
220 kV lines	11387 km
200 kV	859,8 km
120/150 kV lines	45213 km

The high voltage line is unevenly distributed over the Territory, with a density of 93 m/km2 in Northern Italy, 65 m/km2 in Central Italy and 54 m/km2 in Southern Italy. There are 18 interconnection lines with border countries.

The total net power installed in 2005 was 85470.3 MW, with the following shares:

Hydro	20.992,8
Thermal	62.164,7
Geothermal	670,8
Wind and PV	1.642,1

1.2 Energy Supply, Demand and Production: evolution and structure

The Italian energy mix majorly relies on oil and gas imports. Oil utilization is gradually decreasing, while gas and renewable energies are registering a trend of growth.

The shares in energy production in 2005 were the following *(Energy Balance published by the Italian Ministry for Economic Development):*

Shares in Energy Production	
Oil	**43,1%**
Gas	**36%**
Solid fuels	**8.6%**
Renewables	**6.8%**
Electricity (imports)	**5.5%**

Oil consumption has registered a continuous trend of decrease over the last few years. Natural gas demand displays a trend of growth, also driven by the replacement of old oil-burning thermoelectric plants with new turbogas plants.
Electrical energy demand in 2005 amounted to 330.443 GWh. The trend of the last years showed a rate of growth higher than the GDP trend.

Final energy uses (146.0 Mtoe in 2005) registered an increase in line with the GDP increase but with different trends in the different sectors. The transport sector, in particular, showed a relevant trend of increase.

Energy Consumption by sector	
Industry	**28%**
Transport	**30%**
Residential/Services	**32.1%**
Others	**9,9%**

The following tables show the energy shares in export and import per type of energy.

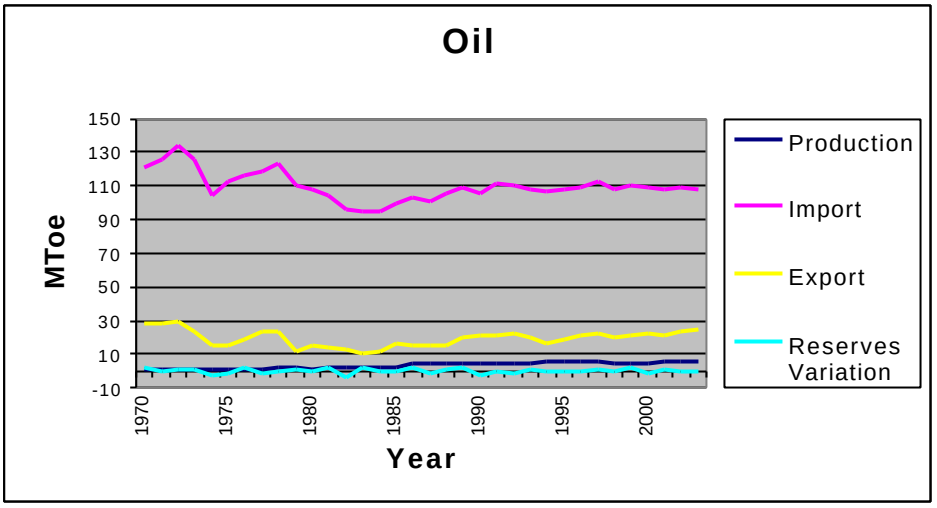


Figure 2: Oil trends from 1970 to 2005

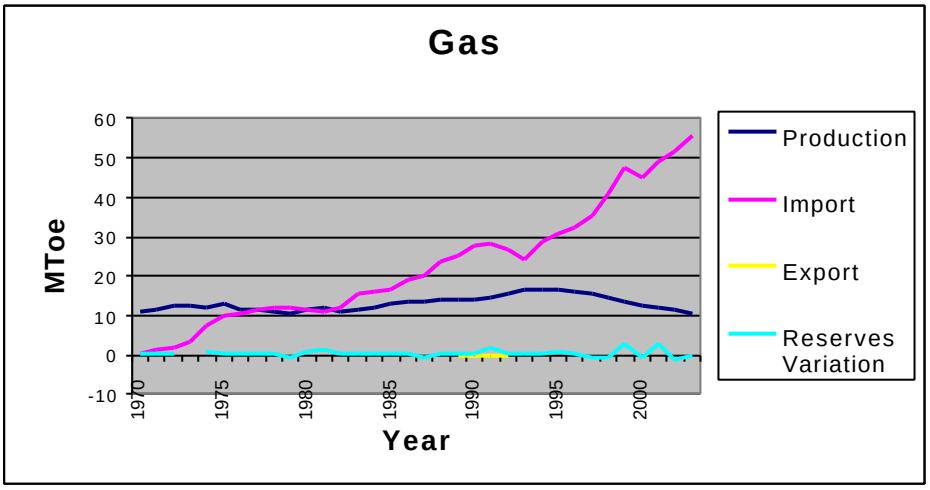


Figure 3: Gas trends from 1970 to 2005

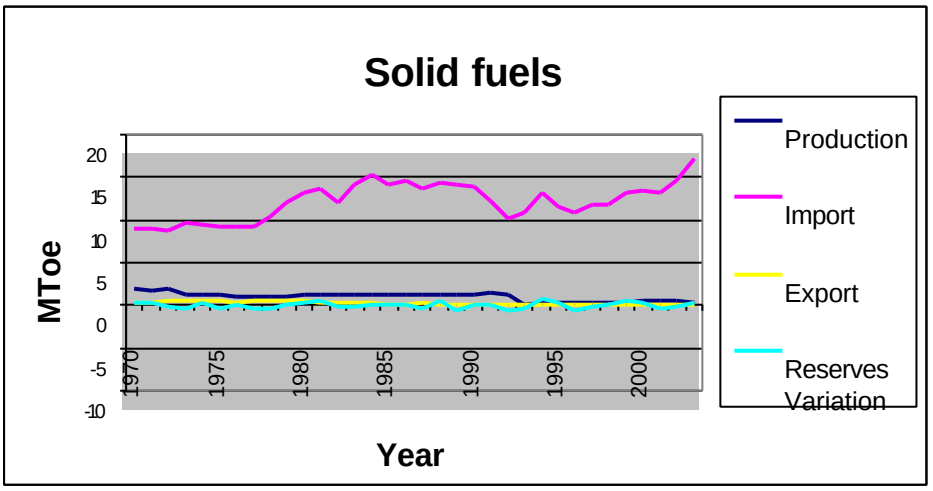


Figure 4: Solid fuels trends from 1970 to 2005

The following data refer to Electricity Consumption by sector in 2004 – 2005:

Activity	2004 M KWh	2005 M KWh	Var %
Agriculture	5.184,8	5.364,4	3,5
Industry	153.155,3	153.726,8	0,4
Manufacturing (basic) (iron and non-iron metals, chemicals, construction materials, paper)	71.525,7	71.726,8	0,3
Manufacturing (non-basic) (food, tessile, mechanical, transportation, plastic materials, wood, others)	64.899,1	65.003,4	0,2
Constructions	1.608,0	1.708,8	6,3
Energy and Water (Combustible Extraction, Refineries, Cokeries, Electricity & Gas, Aqueducts)	15.122,5	15.287,8	1,1
Tertiary	79.557,4	83.793,0	5,3
Commercial services (Transport, Communications, Commercial, Hotels-Restaurants-Bars), Credit and Insurance, others)	61.613,3	65.562,3	6,4
Non commercial services (Public administration, public lighting, others)	17.944,1	18.230,7	1,6
DOMESTIC	66.592,2	66.932,5	0,5
TOTAL	304.489,7	309.816,8	

1.3 Impacts and risks of the observed and forecast evolutions

Despite the gradual shift of the Italian energy mix from oil, the national energy balance still heavily relies on import of fossil sources. This external dependency raises concerns of security of supply and high energy costs. Diversification of supply is a challenging issue, as the options for fuel mix diversification are limited. Apart from the abandoned nuclear option, renewable energies are surely envisaged, while clean coal technologies may foster the coal option. New energy options, such as hydrogen, should be quickly moved from R&D and pilot applications to market.

On the basis of the future population trends (calculated according to ISTAT models) and other factors (number of households, diffusion of electronic devices, etc.) and according to the evolution trend scenarios calculated by ENEA, energy demand will significantly increase in the field of electric uses, especially during next decade. Demand for heating will be increasing more modestly, because of higher efficiency technologies.
Considering the medium to long term, the services and the transport sectors appear to be the most dynamic, while a modest reduction of the industry share is expected, due to the limited growth of the activities and the already high level of energy efficiency.
Energy services demand is expected to basically follow the rate of growth of the economy (1,5%). As regards the transportation sector, the rate of growth of mobility demand is forecast to be 1% for passengers and 2.5% for freight.
Taking into account these figures, the overall energy consumption is expected to grow constantly, following the trend of last decade. The forecast of Total Primary Energy Supply is expected to be 212 Mtoe in 2010 and 243 Mtoe in 2020. The expected annual rate of growth of GDP, TPES and Energy Intensity, according to the trend scenario, are summarised as follows (Data: Ministry for the Economic Development).

	2005 - 2020
GDP	**1.65%**
TPES	**1,38%**
Energy intensity	**-1%**

Taking into account the energy sources, oil and gas will undertake different trends (the former of decrease, the latter of increase), with a common tendency to stabilise towards

values comprised between 35% and 40% of Total primary energy consumption. As for oil, it will register a growth in the transportation sector that counterbalances the trend of decrease in thermoelectric uses, while a relevant reduction has already taken place in the industry and civil sector.
As to coal consumption, after the growth of last years it is expected to stabilise in the short term, while the share could rise again in the medium to long term, due to new energy generation technologies (in particular, gasification). A constant growth is foreseen for renewable energies.

In addition to concerns about energy security and high energy costs, Italy is very vulnerable to climate change effects, in particular in the sectors of agriculture, forestry, water supply, tourism, human health and the service industries, particularly the insurance sector.
The coastal and alpine regions are the most vulnerable. An increase in sea level could worsen damage to infrastructure, property and the tertiary sector in the coastal and lowland regions. In northern Italy soil degradation could take the form of increased erosion due to an increase in rainfall intensity and flooding, while in the south climate change could cause more severe drought, salinization, and nutrient loss.

Human health is expected to be adversely affected, causing an average increase of 27 deaths per annum across Italy if summer mean temperatures rise by 1ºC.

The current situation of greenhouse gas emissions by sector is summarised in the following table. Calculations for energy consumption, whose values are strictly connected with emissions from the energy sector, were made on the basis of the following assumptions:

- GDP growth of 1.4% per year on average;
- Oil prices towards 35 US 2005 dollars in 2025;
- Reduction of GDP energy intensity by 0.3% per year;
- Growth of electricity intensity of GDP by 0.6% per year.

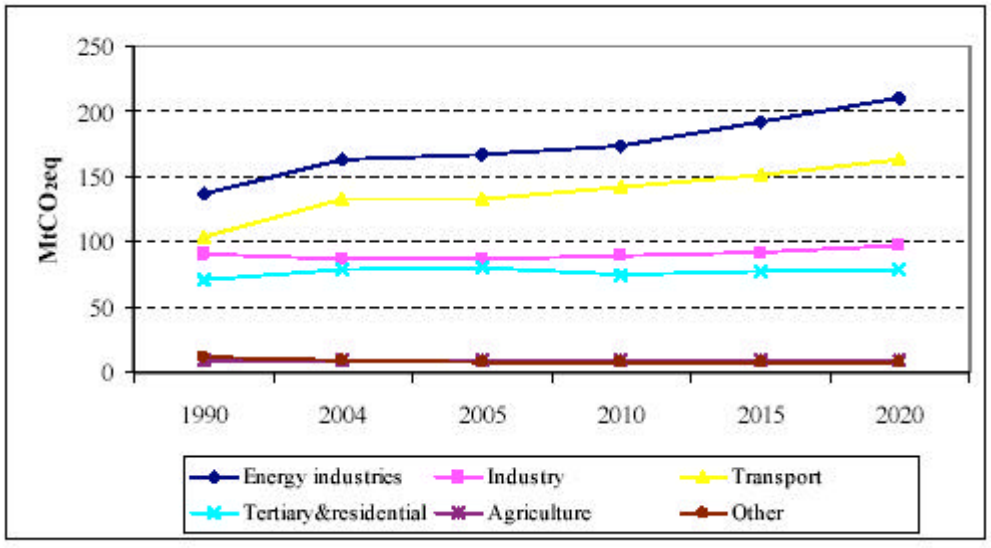


Fig. 5: Greenhouse gas emissions from energy activities: evolution and trends (1990 – 2020) *(Italian report on demonstrable progress under the Kyoto Protocol)*

1.4 Financing and investment needs

The Italian power generation and industry sector is pretty unique compared to those of most industrialised countries. This is due to the following characteristics:

- electricity demand is growing very strongly despite a weak level of economic activity; this is due to the increase in electricity consumption in the residential and industrial sector from the current relatively low levels

- Italy has a high dependency on natural gas and fuel oil; these two fuels have the disadvantage of having prices linked to those of crude oil, which increased dramatically in the last three years

- Italy has a very high dependency on electricity imports with respect to other industrialised countries, with a share of 14% of gross electricity consumption coming from abroad

- Italy has a low level of consumption of coal and the complete absence of nuclear

- the Italian manufacturing industry has already reached high energy efficiency levels, thanks to a continuous technology innovation which has taken place in the last 20-30 years, mainly driven by high energy costs.

Taking into account these considerations, securing energy supply and the fulfilment of the emission reduction objectives are ambitious goals, for which a timely investment is necessary in several sectors.

A significant amount of financial resources has been already planned to put in place several measures and the implementation of some European directives (such as the EU directive on biofuels) will also contribute to drive resources towards a more sustainable energy scenario. In particular, a number of regulatory measures, market-oriented actions and fiscal incentives will be necessary to put in place some of the government priorities, i.e. improving the efficiency of the Italian economy, promoting the efficiency in the electricity sector, reducing energy consumption and promoting technology innovation in the transport sector, increasing the share of Renewables in the energy portfolio, reducing energy consumption in the residential, commercial and industrial sectors and promoting energy sources differentiation and energy security.

At the same time, the modernisation of the country, especially in the South of Italy, requires the expansion of infrastructures, among which those of transport. New infrastructure is expected to enable a reduction of CO_2 emissions and an increase in energy sustainability.

A growth of the renewable energy option is also envisioned, even if markets will have to expand and technologies to improve in order to reach a competitive cost.
Expanding markets in the Mediterranean Region is a priority for the Italian government, that is providing financial support through a range of different bilateral and multilateral programmes. Among multilateral activities, a special mention has to be made on the active involvement in the field of renewable energies: in 2002 Italy launched the Mediterranean Renewable Energy Programme (MEDREP) with the aim to promote renewable energies in the Mediterranean region.

MEDREP's mission follows the recommendation of the G8 Renewable Energy Task Force that countries should develop and demonstrate renewable energy projects where renewable energy is a least cost option on a life cycle basis, and/or renewable energy can protect the local and/or global environment at a reasonable cost.

Within these objectives, the programme aims to develop a sustainable renewable energy market system in the greater Mediterranean Region by establishing financial instruments and mechanisms to support renewable energy projects, strengthening policy frameworks and building stronger private sector infrastructure.

In 2006 Italy also launched the international partnership on Bioenergy (GBEP) with the aim to promote the use of Bioenergy technologies. Italy is chairing the GBEP and has also financed its Secretariat in FAO in Rome. Italy also supports the Methane to Markets Partnership to develop strategies and markets for methane recovery (Landfill methane, coal mine methane, oil and gas systems and agriculture) via research and development, project activities, policy frameworks etc. and the International Partnership for Hydrogen Economy (IPHE) to accelerate the transition to a hydrogen economy. In addition Italy participates in several multilateral programmes launched by IEA, makes contribution to the core budget of the UNFCCC annually, and as of 2005 also makes a contribution to the Kyoto Protocol fund. Italy also makes a variety of voluntary payments to the Trust Fund for Developing Country Participation and the Trust Fund for Supplementary Activities. Furthermore, Italy is carrying out a relevant bilateral cooperation on sustainable energy with China, Balkan countries and USA, mainly devoted to research and development on clean and innovative energy technologies and applications

A rotation fund (Kyoto Rotation Fund) was established by the 2007 financial Law (commas 1110 to 1115), allocating 200 million Euros per year from 2007 to 2009. This fund supports a number of priority actions such as "high performance distributed micro-cogeneration plants for electricity and heat generation" and other interventions (including pilot projects) utilizing renewable energies.
As for the Kyoto flexibility mechanisms, Italy so far has contributed to the Italian Carbon Fund with 108 million USD, to the Community Development Carbon Fund with 7 millions USD and to the BioCarbonFund with 2.5 million USD

Several Capacity Building activities have also been financed, in particular in the Mediterranean Region, Eastern European Countries and China.

The Italian government has also been active in promoting education and training programmes regarding energy efficiency and rational use of energy, both nationally and internationally, as well as research programmes on climate change and energy sustainability.

As for the Mediterranean Region, Italy is further committed in increasing neighbourhood cooperation to improve regional energy infrastructures, such as the electrical interconnections North-South, that are crucial means to improve security in the electrical system.

As for the awareness raising in the field of sustainable energy, several activities and programmes, such as the **“**National System on Environmental Information, Training and Education (INFEA)” have been implemented at national and local level.
Among the most recent initiatives in this field, the Italian Ministry for the Environment Land and Sea is associated to the European Commission for the implementation of the Sustainable Energy Europe (SEE) Campaign in Italy. The aim is to raise public awareness and promote sustainable energy production and use among individuals and organisations, private companies and public authorities, professional and energy agencies, industry associations and NGOs across Europe.

II. RATIONAL ENERGY USE AND RENEWABLE ENERGIES: POLICIES, TOOLS, PROGRESS, RESULTING EFFECTS, CASE STUDIES

2.1 RUE AND RE POLICIES

Socio-economic development is associated directly or indirectly with the energy use, but the energy availability, considering the non-renewable sources, is limited.
Furthermore, energy related activities have a great impact on the environment.
Such a situation requires more responsibility in the treatment of energy questions, through the implementation of appropriate policies.

In Italy, the political institutions began to legislate on renewable energy sources after the energy crises of 1973 and 1978 with the efficiency and renewable energy sources Law 308/82. Since the Kyoto Protocol was ratified, in June 2002, the government has been adopting various policies and measures, such as energy efficiency obligations for electricity and gas distributors and a portfolio obligation of renewable energy in the electricity sector.

2.1.1. Rational energy use (RUE) policies

In order to comply with the commitment taken at the EU level and in order to stimulate the use of energetically efficient technologies, Italy presented on 24 April 2001 two ministerial decrees (then replaced on 20 July 2004 - see par. 2.2.1 Tools and measures in favour of rational energy use), that introduced the obligation to electricity and gas distributors, with more than 100.000 clients, to achieve annual fixed objectives of energy savings for the five-year period 2005/09 through technological interventions to reduce end use energy consumption.
Such objectives may be fulfilled either directly by distributors or by means of controlled societies; alternatively, distributors can buy “Energy Efficiency Certificates” emitted by the Italian Manager of the Electric Market (GME) to the Energy Service Companies (ESCO).
The aim of the two decrees is to achieve by the end of the five-year period a total energy saving of 2.9 million tep, representing the annual increase in energy consumption registered in the period 1999-2001.
The different typologies of intervention for the industrial and civil sectors are annexed to the decrees. The listed interventions relating to renewable energies are the following: photovoltaic, solar thermal, biomass boilers, cogeneration plants and geothermal energy plants.

Building sector

The reference law for energy efficiency in the building sector is the legislative decree n. 192 of 19 August 2005, that complies with the EU directive 2002/91/EC.
This decree introduced standards, conditions and modalities to improve the energy performance of buildings, thus contributing to achieve the emission reduction national objectives fixed by the Kyoto Protocol.

This Law has been reviewed and improved recently through the introduction of the Legislative Decree 29th December 2006, n.311, that introduced new rules that will stimulate the diffusion of energetic plants powered by renewables in the building sector.
Among other several measures and prescriptions, it is foreseen that in all new buildings, or in case of restoration of existing thermal plants at least 50% of the annual primary energy necessary to produce hot sanitary water should be provided using renewable energy sources. This limit is reduced to 20% for buildings located in historical centres.
For new buildings, or in case of restoration, it is foreseen the obligation to install photovoltaic for electricity production with a power capacity to be defined in a ministerial decree.

Furthermore, for new buildings, or in case of restoration, it is obligatory to foresee the setting of all necessary works related to the connection to the district heating network, if this is located nearby, as well as to install a photovoltaic plant for electricity production with a power capacity to be defined in a ministerial decree.

2.1.2. Renewable energy (RE) development policies

The first National Energy Plan was elaborated in 1981, setting actions and targets for the development of renewable energy sources all over the territory. Law 308/82 was the first to address the issues of energy efficiency and renewable energies and established the basis for future public regulations and financial incentives.

Renewable energy technologies started to reach a good level of maturity, new components and systems were set up and concrete applications began to be demonstrated and implemented.

A new National Energy Plan was elaborated in 1988 with five objectives for the year 2000:
1. implementation of policies of energy saving and rational use of energy;
2. protection of the environment and human health;
3. development of national energy sources;
4. utilization of mixed energy sources and different geopolitical supplies;
5. improvement of competitiveness of the production system.

Afterwards, all legislation regarding rational use of energy, energy savings, renewable energy sources and assimilated sources has been based on the principle of such objectives. For example, Law 9/91 liberalized electricity production from renewable energy sources and simplified the authorization procedures, while Law 10/91 required Regions to draw up energy plans, highlighting that the use of renewable energy sources was in the public interest and the implementation of related measures was a priority.

The following measure CIP 6/92 (Interministerial Price Committee) of 29 April 1992 encouraged electricity generation from renewables by setting incentivated prices for its sale for a period of 8 years.

Following the publication of the European Commission's White Paper on renewables, Italy adopted a White Paper on the exploitation of energy from renewable sources, then approved by CIPE (Interministerial Committee for Economic Planning) in its Decision No 126 of 6 August 1999. This document gave the state of the art of RE technologies and indicated policies, strategies and production targets up to 2008-2012 for each type of source (see the table below). In particular, the White Paper pointed out a more important role of the Regions in supporting the national policies to achieve the targets by regional and local initiatives and measures.

	1997		2002		2006		2008/2012	
Source/technology	MWe	TWh	MWe	TWh	MWe	TWh	MWe	TWh
Hydro > 10 MW	13942	33.47	14300	34.32	14500	34.8	15000	36
Hydro = 10 MW	2187	8.12	2.400	8.88	2600	9.62	3000	11.1
Geothermal	559	3.90	650	4.78	700	5.14	800	5.9
Wind	119	0.12	700	1.4	1400	2.8	2500	5
Solar	16	0.01	25	0.03	100	0.11	300	0.3
Biomass and biogas	192	0.57	380	2.28	800	4.80	2300	13.8
Waste	89	0.25	350	1.75	500	2.50	800	4.0
Total	17104	46.44	18805	53.44	20600	59.77	24.700	76.1

Currently, support for renewable energy is based on:
- market-based mechanism of “green certificates” for electricity production;
- national and regional financial contribution;
- RECS and certifications;
- National and EC funds for R&D;
- fiscal incentives.

Direct incentives in capital law are today mainly competence of regional and local authorities, while central government is consolidating market-based mechanisms, fiscal incentives and laws prescriptions (such as in the building sector).

2.1.3 Electricity production from renewable energy sources

One of the most important legislative decrees introducing new incentives for electricity produced from renewable energy sources was decree 79 of 16 March 1999, concerning the restructuring of the electricity sector in compliance with Directive 96/92/EC.
In particular, it introduced:
- in article 11, the scheme to incentive the electricity production from renewable energy sources, called “*green certificates mechanism*”;
- the priority in dispatching electricity from renewable energy sources;
- transitory norms for the CIP6/92 power plants, both those already connected to the grid and those that will be connected in the next future;
- specific incentives to the electricity from renewable energy sources. Regions will manage the funds according to a mechanism based on call for tender system.

Another important piece of legislation supporting renewables for electricity production is legislative decree n. 387 of 29 December 2003, implementing the European directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market.
This decree introduced additional measures improving incentives and supporting Renewables.

For instance, article 4 set the annual increase of 0.35% for the minimum obligation quota of electricity produced from renewables to be fed into the national grid, in the period 2004 to 2006 (see paragraph 2.2.2 for the explanation of the mechanism). A provision was also introduced whereby the Minister for Production Activities (currently Minister for Economical Development), in concert with the Minister for the Environment and Territory (currently Minister for environment, Land and Sea), having consulted the Unified Conference, was to issue decrees establishing further increases of the minimum quota for the three-year period 2007-2009 and the three-year period 2010 - 2012.

With regard to specific sources, article 7 of Legislative Decree 387/03 stipulated that further decrees would lay down the incentive criteria to support electricity production from solar sources.

Furthermore, in order to simplify the authorisation procedures, article 12 of Legislative Decree 387/03, established that construction and operation of plants producing energy from renewable sources are subject to a single authorisation, issued by the Region (or another official body empowered by the Region) following a single procedure (lasting no more than 180 days).

In addition, with reference to EC directive 2001/77/EC, requiring Member States to ensure that the origin of electricity produced from renewable energy sources can be guaranteed as such, article 11 of Legislative Decree 387/03 established that producers can require the “Guarantee of Origin” for the electricity produced by qualified plants using renewable sources. The Manager of Electrical System (Gestore del Sistema Elettrico – GSE) is the

entity designated to issue the Guarantee of Origin, as well as green certificates. The Guarantee of Origin is issued when the annual production, or attributable production, is not less than 100 MWh, rounded off in accordance with commercial practice.

2.2 INSTRUMENTS AND MEASURES TO BE TAKEN IN FAVOUR OF RUE AND RE

2.2.1 Tools and measures in favour of rational energy use (RUE)

White Certificates Mechanism to support Energy Efficiency Measures

This market-based mechanism has been introduced by the two Law Decrees "20th July 2004" and represents the main tool to promote energy efficiency measures in Italy. Each white certificate (WC) testifies the saving of 1 ton of oil equivalent (toe) achieved through the implementation of specific projects. WCs are emitted by the Italian Manager of the Electric Market (GME) on the basis of the energy savings certified by the Italian Authority of Gas and Electricity (AEEG).
The functioning of this mechanism is based on the obligation to electricity and gas distributors with more than 100.000 clients, to achieve annual fixed objectives of energy saving for the five-year period 2005/09. Further decrees will define the modalities for the application of the provisions of these Decrees to distributors with less than 100'000 clients.
The annual energy saving objectives increase year by year and can be achieved through the implementation of specific projects (e.g. installation of high efficient boilers, thermal insulation interventions, etc.) with end-users that will benefit directly from the consequent reduced energy expenditures.
When a distributor does not satisfy its annual obligation through the implementation of projects, it can buy white certificates generated by interventions implemented by other operators.

The aim of the Law Decrees is to achieve by the end of the five-year period a total energy saving of 2.9 million toe, representing the energy consumption annual increase registered in the period 1999-2001.

Electricity

Year	target (Mtoe)
2005	0,1
2006	0,2
2007	0,4
2008	0,8
2009	1,6

Gas

Year	target (Mtoe)
2005	0,1
2006	0,2
2007	0,4
2008	0,7
2009	1,3

Energy saving fixed targets for gas and electricity (Law Decrees 20th July 2004)

Results achieved in 2005
2005 was the first year of application of the White Certificates mechanism. The 2005 energy saving objective was 152,000 toe, while the certified achieved result was about 287,000 toe (the objective is referred only to distributors with more than 100,000 clients).
This result is the consequence of projects started in 2001. Almost 75% of these projects have been devoted to reduce electrical consumption; 22% reduced natural gas consumption; 3% reduced energy consumption from other sources.

The total energy saved in 2005 is equivalent to the overall domestic consumption of an Italian city with 380,000 inhabitants or to the annual electrical production of a 160 MW power plant. The total CO_{2eq} avoided emissions were more that 750,000 tons.
During 2005, 13,898 white certificates were traded, representing almost 9% of the overall 2005 objective.

Fiscal and Administrative Measures to Support Energy Saving
Energy saving is also boosted through specific fiscal and administrative measures, generally introduced each year with the Financial Law, such as:

- deduction from taxes of a certain % of total cost of the interventions
- reduced taxation (such as VAT) for clean technology equipments and systems
- reduction/rationalization of administrative procedures and costs.

2.2.2 Tools and measures in favour of renewable energy (RE)

Green Certificates Mechanism
The most important mechanism incentivating electricity produced from renewable sources was introduced by Legislative Decree 79 of 16 March 1999 and completed by the subsequent Ministerial decrees of 11 November 1999 and 18 March 2002.
The new approach to support renewable sources consists in an obligation, starting in 2002, for producers and importers of electricity produced from non-renewable sources to supply the electricity grid with a minimum quota of electricity produced by plants which use renewable sources and which started operating after 1 April 1999. The quota, initially set at 2%, is calculated on the basis of electricity production and imports of the previous year, exceeding 100 GWh, net of co-generation output and internal power plant consumption and exports.

The decrees of 11 November 1999 and 18 March 2002 defined as eligible to contribute towards achieving the quota those plants using renewable sources and which began operating after 1 April 1999 following new construction, upgrading, total or partial reconstruction or re-activation; it is also eligible new energy production from renewable sources - also in existing plants - obtained by means of co-combustion, i.e. simultaneous combustion of non-renewable fuels and solid, liquid or gas fuels obtained from renewable sources.

Green certificates can be traded on a parallel market independent of the electricity market. In the green certificates market, demand is generated by the quota obligation to electricity producers and importers; offer is generated by the electricity produced from renewable energy plants (operating after 1 April 1999).
GSE is the authority corroborating that the plant is powered by renewable sources, thus issuing the qualification certificate IAFR.
The entity subjected to the quota obligation can generate green certificates from its own renewable plants or can buy green certificates generated by other renewable electricity producers. The exchange of green certificates can be made either bilaterally among operators or using a platform facility organized by the Manager of the Electric Market (*Gestore del Mercato Elettrico – GME*)

For entities not fulfilling the obligation, the Ministerial Decree of 11 November 1999 introduced penalties which consist in restricting their access to the electricity market as a whole.

Feed-in tariff scheme for photovoltaic
Following the decree 387/2003, that prescribed the establishment of incentives for electricity production from solar sources, the ministerial decree approved on July 28th 2005

(modified/integrated on February 6th 2006) introduced in Italy the feed-in tariff to support photovoltaic.

The Decree 19 February 2007 introduced a new version of the feed-in tariff. The new scheme is applied to PV plants connected to the grid with a nominal capacity higher than 1 kWp realised by individuals, registered companies, condominia and public bodies.

The decree foresees a set of tariffs, valid for a period of 20 years, according to the following table:

		1	2	3
	Plant nominal capacity (kWp)	**Not integrated**	**Partially integrated**	**Full integrated**
A	1 < P < 3	0,4	0,44	0,49
B	3 < P < 20	0,38	0,42	0,46
C	P > 20	0,36	0,40	0,44

A tariff increase of 5% is foreseen:

- for B and C for energy self-producers, as defined by the Law Decree 79/1999
- for public schools and public health centres
- for installations integrated to building substituting asbestos roofs
- if the owner is a municipality with less than 5000 inhabitants.

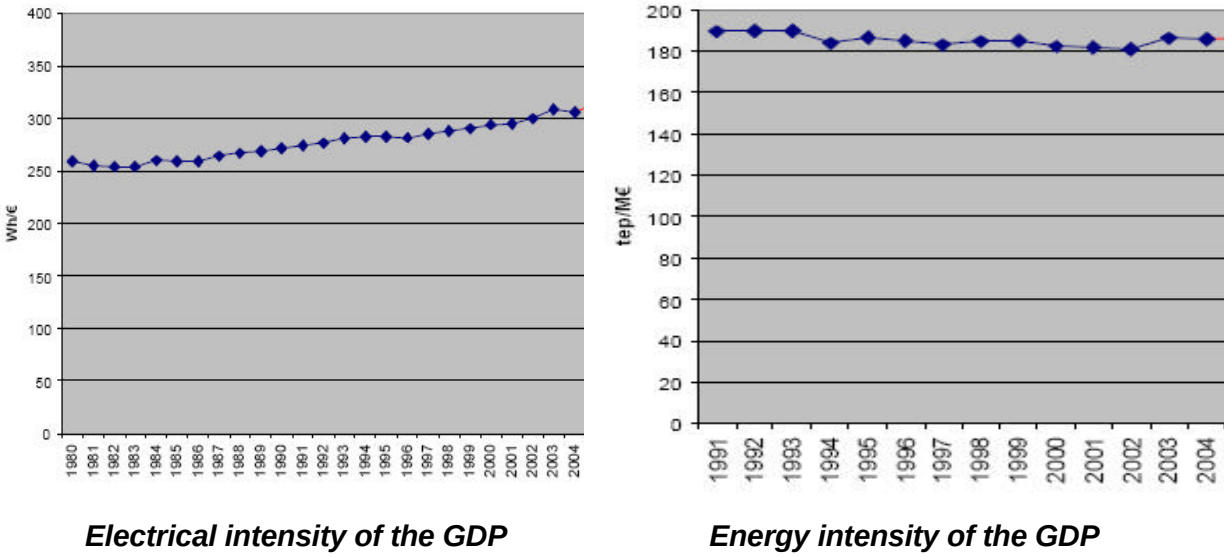
Furthermore, other increases of the tariff can be obtained, as premium, in case energy efficiency interventions that decrease the energy performance index of the building are implemented.

Plants with a capacity lower than 20 kWp can further benefit of net metering, meaning that customer will not pay the electricity bill if the electricity fed to the grid balances the electricity taken from the grid.
Otherwise to the net metering, the electricity not consumed by the user is sold to the grid to a fixed price.

This mechanism is valid till the achievement of 1200 MW installed. The national indicative objective of PV installed capacity is 3000 MW to 2016.

2.3 Energy Efficiency Evolution - decoupling[1]

The trend of various parameters is shown in the following graphs:



Electrical intensity of the GDP ***Energy intensity of the GDP***

Fig. 6: Electrical and Energy Intensity of the GDP

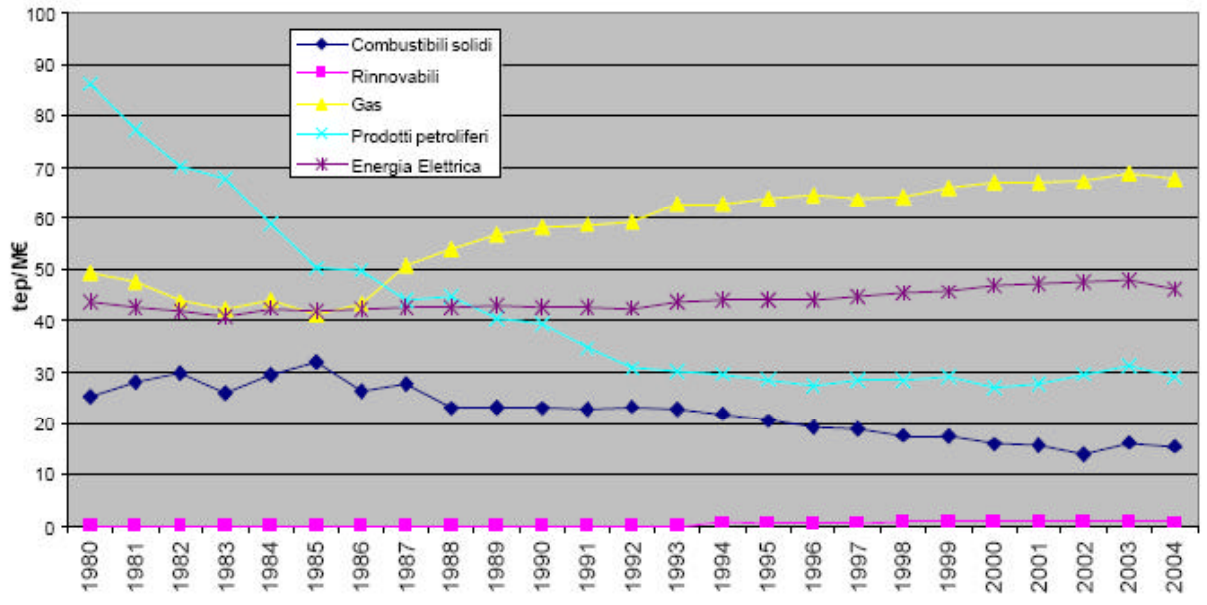


Fig. 7: Energy intensity of the industrial sector

The industrial sector absorbs around 30 % of the total primary energy consumption. The energy intensity of the industrial sector started to decrease with a constant rate mainly thanks to the energy efficiency policies started in the second half of '70. From '70 up to date, energy intensity has decreased by 45%.

[1] Energy data reported in this paragraphs come form the source "Scenari Energetici tendenziali 2020" of the Ministry for Economic Development

It can be observed the following:

- Natural gas is quickly replacing oil fuels and is moving to saturation
- Solid fuels are decreasing
- Electricity shows a modest increasing trend from the second half of '80s
- Renewable energies started to play a role since the second half of '90s

An energy efficiency programme for the industrial sector should take into account that the Italian productivity sector is constituted mainly by small and medium enterprises generally grouped in industrial districts.
In this context, efforts to increase energy efficiency should be made in the following fields:

- Technologies for the self-production of energy
- Energy valorisation of industrial wastes
- Re-organisation of the production process in order to make it more efficient
- Ad-hoc incentives for energy efficiency.

The civil sector, composed by the Tertiary and Residential sectors, absorbs around 30 % of the total primary energy consumption.

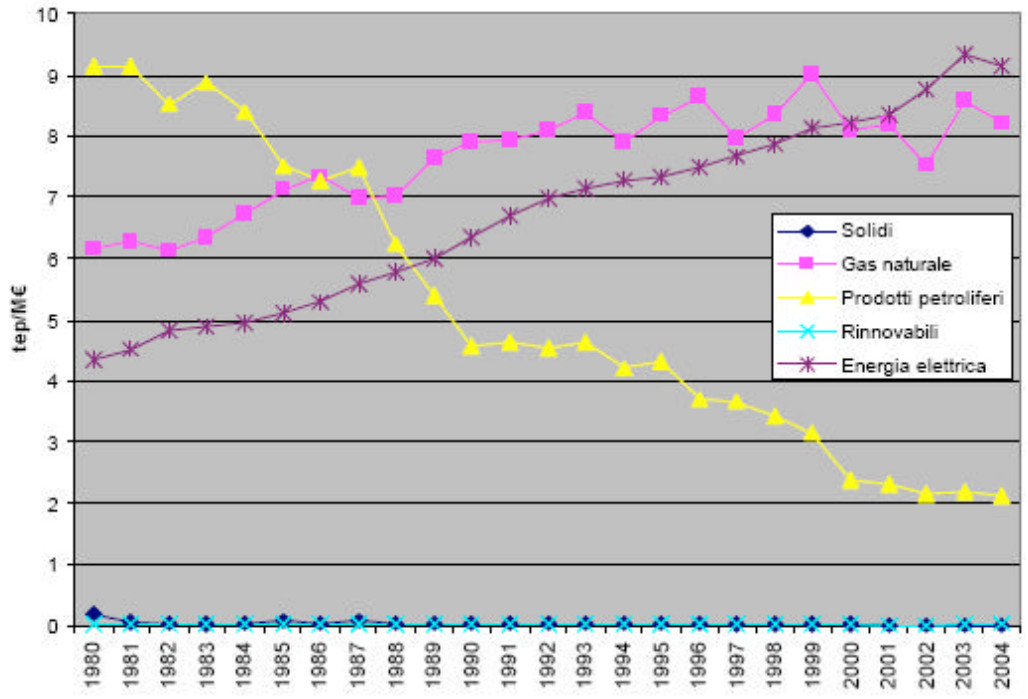


Fig.8: Energy intensity of the Tertiary sector

Italian energy intensity in the tertiary sector is still the lowest in the EU, but the trend shows an increase due to the diffusion of cooling systems and the consequent increase of electricity intensity.
It can be observed the following:

- Oil fuels for heating are being gradually replaced by natural gas
- Oil products are decreasing towards the saturation values corresponding to their utilization in areas far from gas and electricity facilities
- Electricity intensity is increasing because of cooling systems diffusion
- The utilization of renewables is slowly increasing

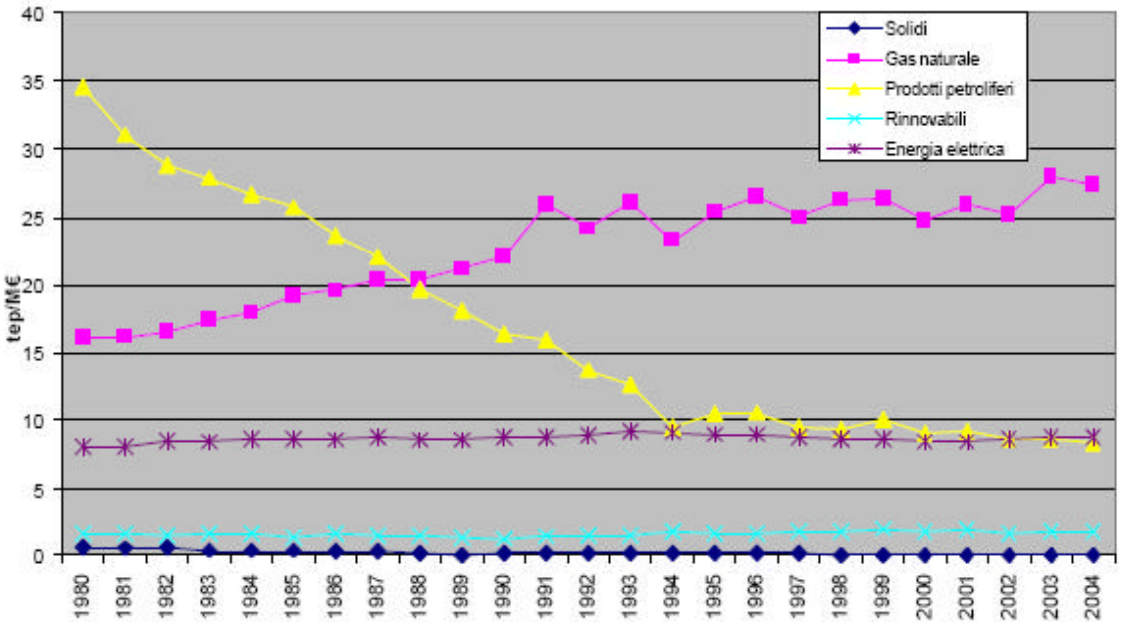


Fig. 9: Energy intensity of the residential sector

As for the residential sector, the electricity intensity and the other typical indicators, such as the unitary electricity consumption per house, generally increase with the increasing of the "per capita average income". This can be generally observed in the European Union. In this context, Italy shows an almost constant value in time for the electricity intensity, as well as one of the lowest values - among all member states - for the unitary electricity consumption per house. This is due mainly to the high electricity tariffs for families, that acted as a demand side management policy.
Anyway, the diffusion of electrical appliances for climatisation - mainly for air conditioning - made the electricity intensity trend increasing in the very last years, but with a rate substantially lower than the tertiary sector. The progressive increase of electricity consumption in the residential sector represents an inversion of trend in Italy, where electricity represents only 30% of the total energy final uses in houses.
The decreasing of energy intensity in the residential and tertiary sectors should be made in the following fields:

- Improvement of the efficiency of existing buildings, usually old and not renovated, with particular focus on the Public estate
- Improvement of the national electricity generation system through the diffusion of the micro-poly-generation distributed systems
- Inversion of the trend of increase of electricity consumption due to the diffusion of air conditioning systems
- Increase of the "energy quality" of appliances and other domestic products by improving standards and technologies

In the residential sector a great contribution to increase energy efficiency was given by the introduction of the Legislative Decree n.311 of 29 December 2006, that introduced the following measures:

- Obligation of Renewable Energy systems for at least 50% of hot water demand
- Obligation of photovoltaic plants for new buildings
- Introduction of the "Energy Certificate" for buildings
- Simplified procedures for the substitution of old boilers with more efficient ones
- Obligation to introduce "sun protection systems" for new and restored buildings

- Obligation for all new buildings to carry out all necessary works related to the connection to the district heating network, if this is located nearby
- Introduction of sustainable energy criteria in urban planning

The transport sector absorbs around 30 % of the total primary energy consumption.

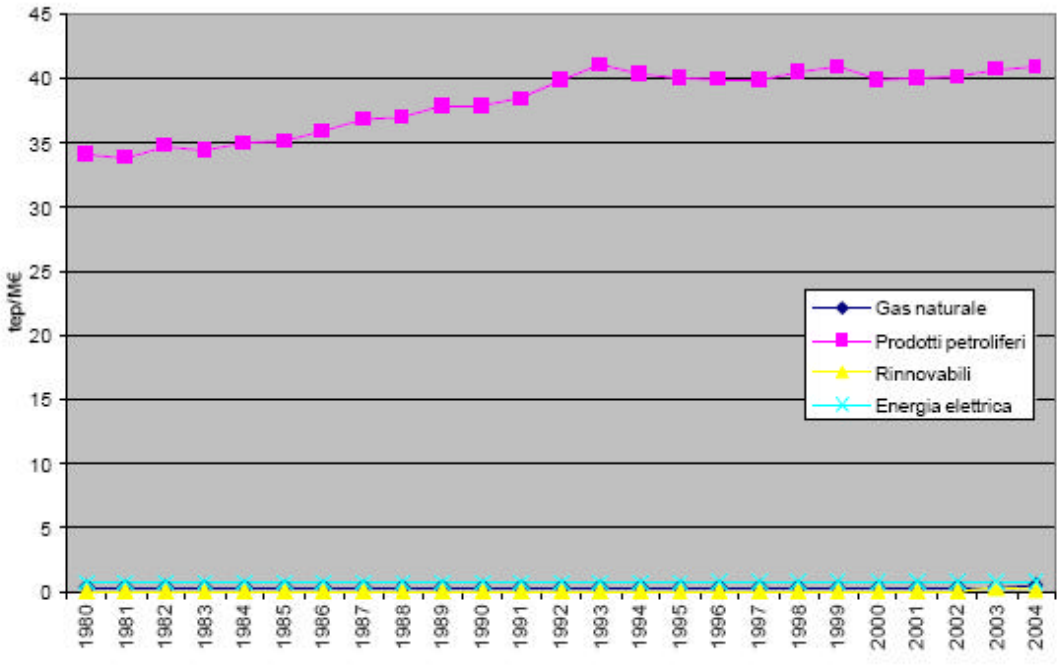


Fig. 10: Energy intensity of the Transport sector

The rationalization of energy consumption in this sector is one of the main challenges in Italy, being the transport sector dependent from imported oil products and among the main responsible of CO2 emissions.

After the increasing trend of energy intensity due to the motorization of the country, until the early '90s, today the trend is constant.

The efficiency of technologies and engines has been improved, but the energy consumption of the sector is increasing rapidly together with the emissions and the consequent impacts on the environment.

The main actions to be taken in order to decrease energy consumption of this sector and its negative effects are the following:

- Policies for the management of the territory and of the "mobility demand"
- Improvement of transport infrastructures aiming at improving collective transport and decreasing "road transport"
- Efficiency improvement of transport technologies and engines and promotion of low-consumption vehicles
- Introduction of biofuels and low-emissions fuels (natural gas)

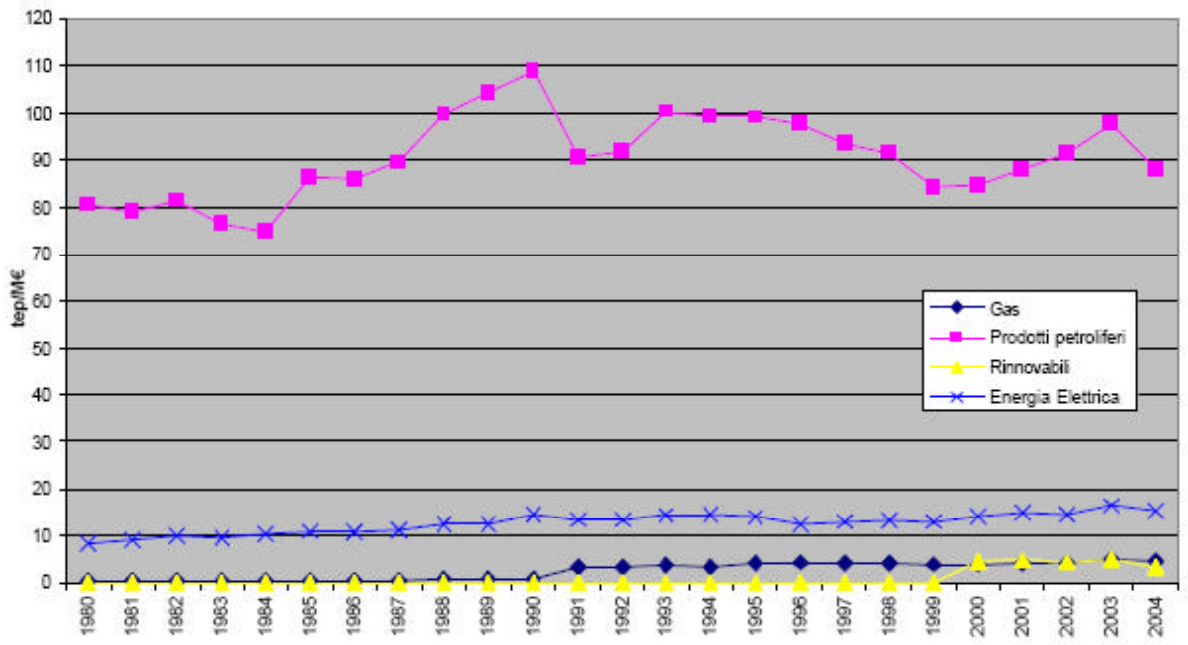


Fig:11: Energy intensity of the Agriculture sector

The energy intensity of the agricultural sector is strictly dependent from oil products because of the predominance of "engines for agriculture".
In this sector, renewables show a gradual increase essentially due to the utilization of biomass for heat production.

The Electric sector

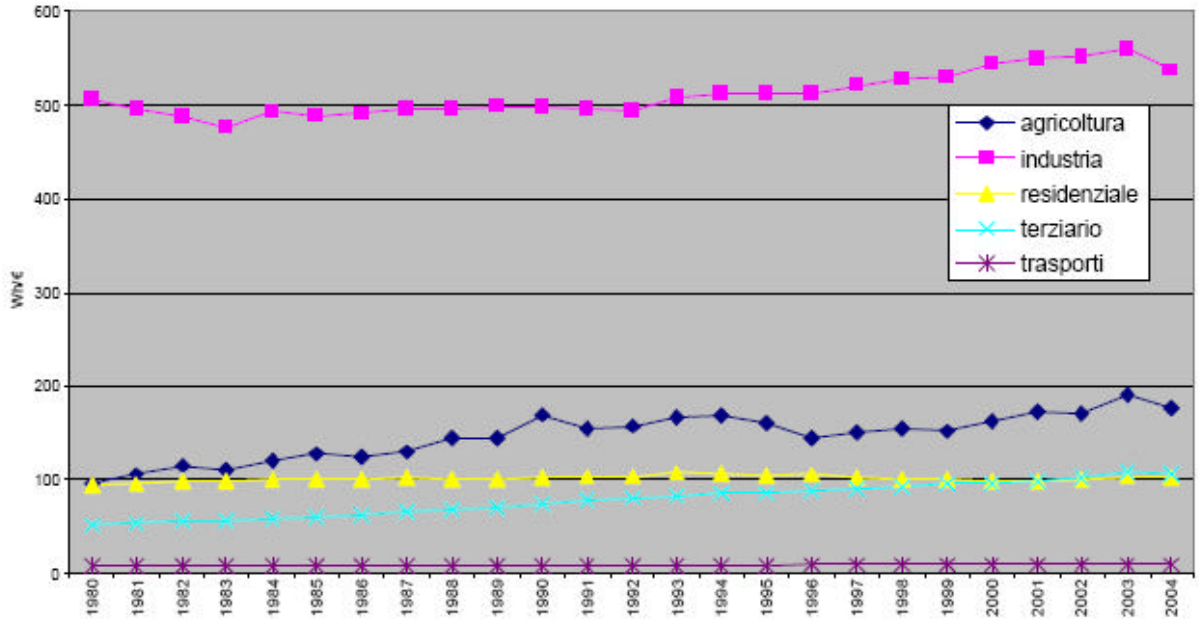


Fig.12: electric intensity per sector

Electricity consumption data - 2005			
	Energy Intensity PPP (GDP 1995)	*Per capita consumption*	*Density*
	kep / $	**kWh / inhabitant**	**MWh / km2**
World	0,23	2302	136
Europe	0,18	6352	679
UE 15	0,17	6251	764
Italy	0,13	5286	1054

Source: Terna

More than 83% of the gross electricity production comes from thermal-electric plants. The average efficiency of the thermal-electric generation system is continuing to increase year by year, as shown in the figure below.

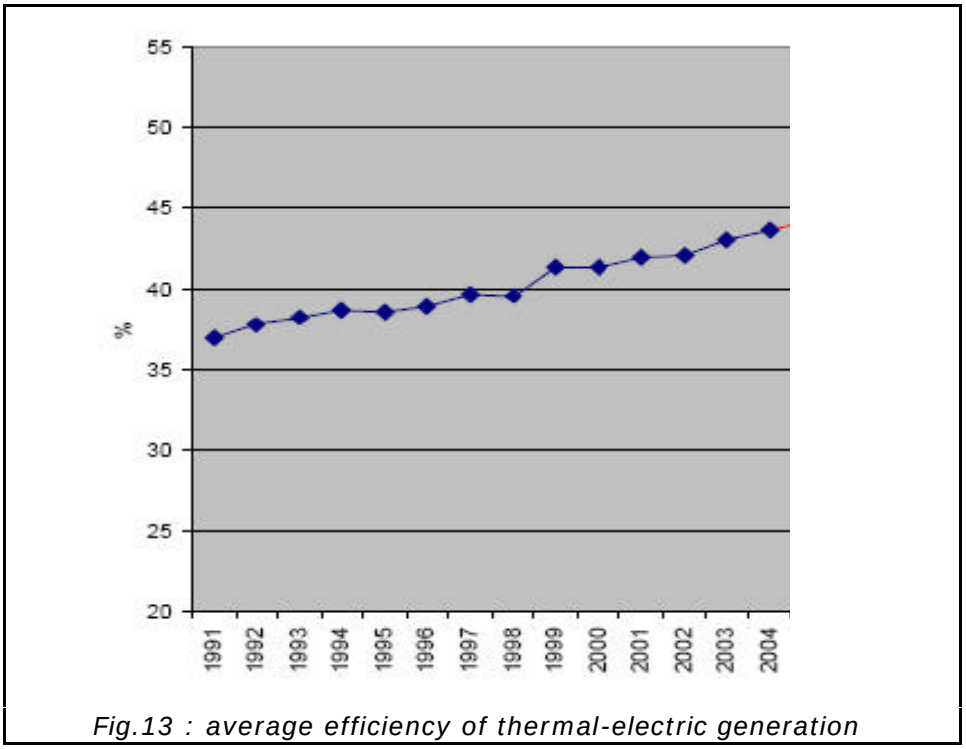


Fig.13 : average efficiency of thermal-electric generation

The “trend scenario” for the Italian electrical system foresees that the average efficiency of the thermal-electric generation system will overcome 50% in 2015.

Electrical losses in 2005 was 20,6 TWh, representing more than 6% of the total electricity demand (330,4 TWh). Considering that the electricity deficit in Italy is close to 50 TWh, there is the real need to minimize losses through the electricity grid. In this regard, the diffusion of the distributed generation will help achieve this goal.

2.4 Renewable Energy evolution

In the electric sector, the total renewable energy installed capacity in 2005 was 20.9 GW, with an increase of 4 % compared with the year 2004. The corresponding electricity production has been 49.9 TWh.

Although hydropower still represents the main electricity source from renewables, with 72% of the total production, the highest grow rate belongs to wind energy, increased by 49% in 2005 compared to the value of 2004. This was a good signal after some delay due to territorial constraints and long administrative procedures, as well as local resistance to new infrastructure.
In fact, even if the general opinion towards renewable energies is certainly positive, one of the main issues regards public perception about their impact on landscape. This issue is of particular relevance in territories with a huge artistic and landscape heritage. The impulse recently given to renewable energies, particularly wind and photovoltaic, needs therefore to be homogenized with administrative rules taking in consideration the safeguard of historical, environmental and landscape heritage. This requires coordination among all institutions involved and responsible for environmental protection and cultural safeguard.

Renewable Energy - 2005	MW	GWh
Hydro	**17,325.8**	**36,066.7**
0-1 MW	*419,4*	*1,525.7*
1-10 MW	*1,986.1*	*6,090.5*
>10 MW	*14,920.3*	*28,450.5*
Wind	**1,639**	**2,343.4**
Photovoltaic*	**34**	**31**
Geothermal	**711**	**5,324.5**
Biomass and Wastes	**1,119.8**	**6,154.8**
Solid	***915,9***	***4,956.9***
Urban solid wastes	*526.5*	*2,619.7*
Crops and agriculture wastes	*389.4*	*2,337.2*
Biogas	***283.9***	***1,198***
Landfills	*236.8*	*1,052.3*
Sludges	*4.7*	*3.2*
Animal wastes	*6.9*	*25.7*
Crops and agriculture wastes	*35.5*	*116.8*
Total	**20,909.5**	**49,920.4**

Source – GSE

As for photovoltaic, its development still lags behind its huge potentialities, but a deep increase is expected in 2007 thanks to the entry into force of the feed-in tariff introduced in July 2005. Up to the end of 2006, 387.7 MW had been admitted to benefit from the feed-in tariff, of which 6 MW already installed and 62 MW on course of installation.

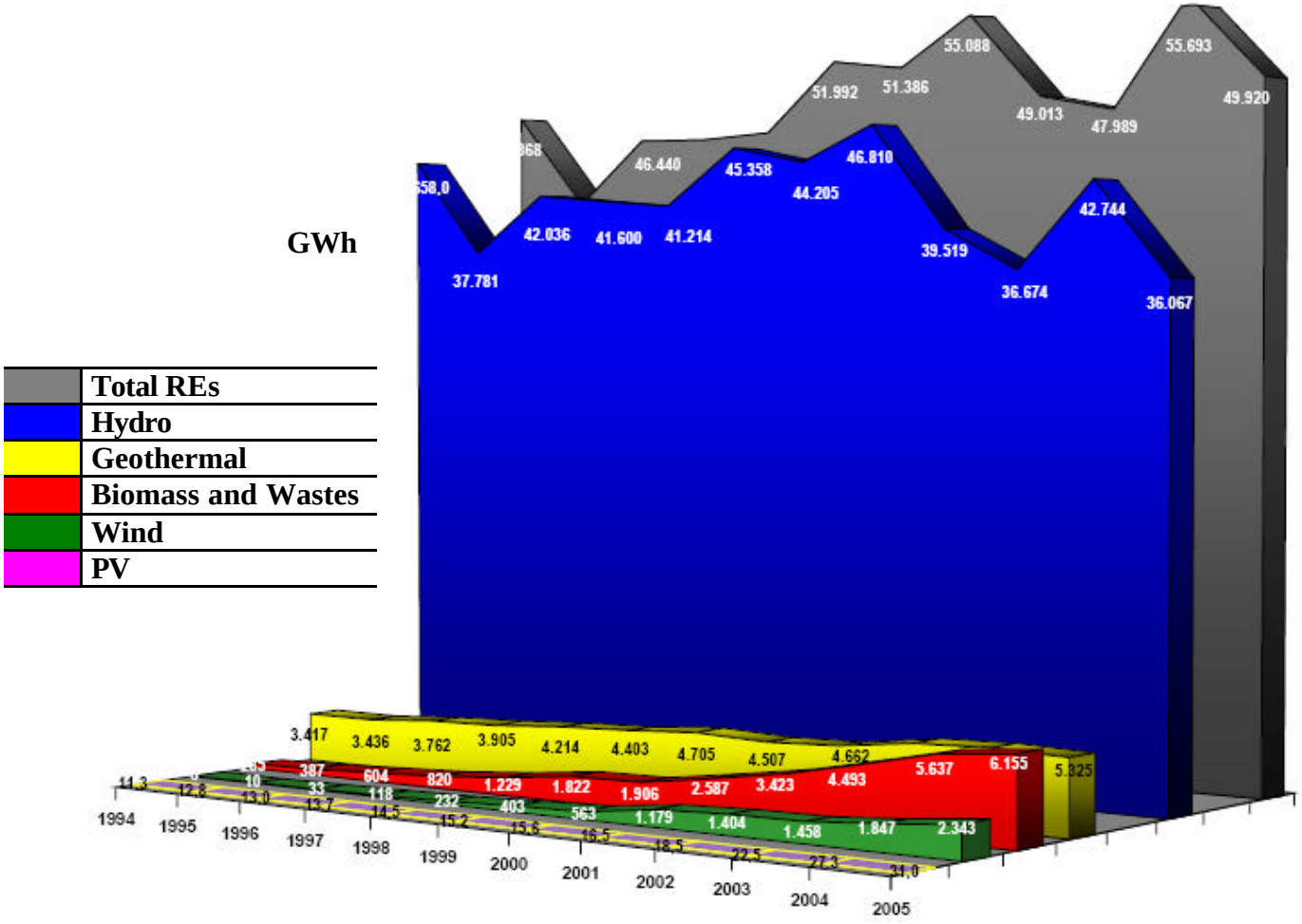


Fig.14: Renewable Energy gross production trend (1994-2005) – source and elaboration: GSE

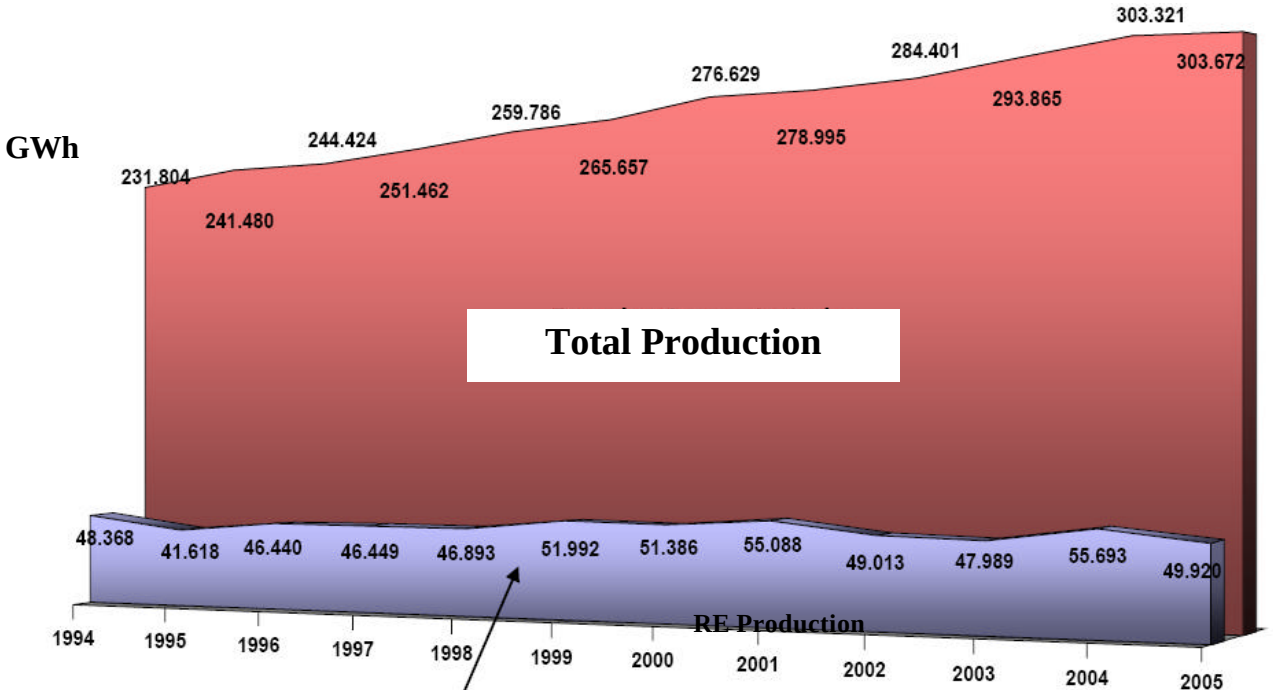


Fig. 15: Comparison between total and renewable energy electricity gross productions (1994-2005) – source and elaboration: GSE

The 2005 renewable energy electricity gross production represented 16,4 % of the total gross production, 15,1 % of the total electricity demand (net consumption + network losses = 330,4 TWh), and 14,1% of the gross inland consumption (352,8 TWh). This last percentage rises to 17,3%[2] if we consider the importation of electricity from renewable energy sources certified through the Guarantee of Origin.

[2] *provisional data in 2005*

III. ENERGY TECHNOLOGIES CASE STUDIES AND GOOD PRACTICES

3.1 CdTe/CdS Thin Film Solar Cells industrial production

This is an ongoing project in Italy with the aim at developing an industrial process for a large-scale low-cost production of photovoltaic CdTe thin film modules.

The entry into force, in Italy, of the feed-in tariff scheme to boost photovoltaic is leading to a deep increase of PV products demand that creates a sudden shortage of such products. In the short and medium term this could lead to an increase of technology costs and to a strong reliance of foreign supply.

For this reason, starting from the most recent research studies carried out in Italian Universities (University of Parma), it has been decided to implement a project on innovative PV manufacturing cycle for the industrial production of CdTe thin film able to reduce significantly the costs.

Thin film modules may become cost-competitive for at least three reasons:

- The amount of source material is at least 100 times lower than the amount used for single crystals modules and it is a negligible part of the overall cost
- The manufacturing process can be completely automated and a production yield of one module per minute can be obtained
- Low cost soda lime glass can be used as a substrate

A stable efficiency of 15.8% has been demonstrated for 1 cm^2 laboratory cell and it is expected that an efficiency of 12% can be obtained for 0.6x1.2m^2 modules.

A fully automated in-line process with a capacity of 15-20 MW/year could produce 1 module every 2 minutes at a cost substantially less than 1€/W.
It is estimated that, if the production of a single industrial plant will be higher than 100 MWp/year, a production cost of less than 0.5$/Wp is possible

This costs should be compared with the traditional ones that, in Italy, range between 3 to 4.5 €/W.

3.2 Sino-Italian Ecological and Eco-Efficient Building at Tsinghua University (Beijing, China)

In 2000 the Italian Ministry for the Environment and Territory and the Chinese Authorities established a Sino-Italian environmental cooperation programme, including several joint projects in the environmental field. In this framework, the Sino-Italian Eco-Efficient Building (SIEEB) was conceived with a view to creating a visible and active centre of research, testing and dissemination of efficient and low-carbon technologies in the building and housing sectors. SIEEB was inaugurated in 2006 as an intelligent, ecological and energy efficient building, that will serve as a model for a new generation of buildings and a concrete example for the dissemination of sustainable practices in the building industry. At the same time SIEEB is a laboratory for the development of innovative technologies in the energy efficiency field. SIEEB covers an area of 20.000 m^2, is around 40 meters high, and will host an education, training and research centre for environmental protection and energy conservation, offices and a 200 seats auditorium. Envelope components, control systems and technologies employed in the SIEEB represent the state of the art of the innovative Italian production in the building sector.

Design Methodology

As a sustainable, low emission building the envelope and building services have been conceived as an integrated system since the earliest steps of the design process.
Starting from the shape definition, a large number of possible configurations were firstly examined, using appropriate computer tools capable to evaluate the actual amount of solar radiation incident on the facades and taking into account the shadows cast by surrounding buildings. The final shape derived from an iterative series of tests and simulations supported by an intense dialogue between energy experts and architects.

Energy Analysis

The shape developed in the first step was then refined and adapted to more detailed formal and functional requirements and energy simulations were carried out. Building energy analysis showed that, in order to minimise carbon emissions, the key issue was electricity consumption, mainly because of the carbon based electric production system in China. Hence, the following design strategies were derived:

- maximise natural lighting and minimise artificial lighting
- minimise the electricity demand of heating, ventilating, and air-conditioning systems (HVAC)

- meet as much as possible the electricity demand of the system by means of cleaner production systems

Maximise natural lighting and minimise artificial lighting

Window dimensions were optimised taking into account natural lighting, glare, energy losses and solar gains. The effect on artificial lighting demand of the most advanced techniques and technologies for enhancing natural lighting (such as light shelves, fixed and movable reflecting lamellas, prismatic louvers and laser cut transparent devices) was also explored and evaluated making use of appropriate computer simulation tools. The final design is the result of an iterative process involving energy and architectural issues. Part of the artificial lighting demand is met by the electricity production of photovoltaic louvers.
Particular attention has been given to the study of a light shelf integrated in the façade. Moreover, an automatic light flow adjustment system is used for the offices and laboratories. Photosensors detect presence and luminescence, thus regulating the required light flow in the rooms.

Minimise electricity demand

The HVAC system chosen for the SIEEB is among the most efficient, combining displacement ventilation and radiant ceilings. Displacement ventilation allows for a significant reduction of the electricity consumption due to fans and provides high air quality. Radiant ceilings provide high standard thermal comfort exploiting the longwave radiative energy exchanges between the occupants and the enclosure and allow for low electricity consumption (only for pumping hot or cold water through them).
Moreover, energy demand - for heating air in winter and for cooling and dehumidifying it in summer – is reduced. A sophisticated control system adjusts the air changes and temperature in each room according to its actual occupation. Computer simulations show that the adoption of this HVAC system instead of the usual ones allows for more about 30% reduction of primary energy consumption.

Electricity from cleaner production systems

The SIEEB building adopts the tri-generation concept and several technological and operational options were explored by means of computer simulations, aiming at assessing the best performance of the whole system comprising building, HVAC and tri-generation units.
The desiccant cooling system was excluded because of its poorer performance compared with a double stage absorption chiller. Simulations showed also a mismatch between thermal and electrical power demand: sometimes, when thermal loads are low, electricity production is not sufficient and some power should be taken from the grid. Some other times the cooling loads are so high that too much electricity would be produced. To overcome this problem, compression heat pumps were added. They are powered with the excess the electricity produced by the tri-generation system, whose instantaneous power is modulated with an appropriate control system. In this way, there is no need for electricity exchange with the grid. The tri-generation concept was adopted also for another reason: in a more or less near future the SIEEB could become a zero emission building. This is possible by using biofuels instead of natural gas to power the engines, simply adapting or substituting them. A more long term scenario includes the use of fuel cells powered by hydrogen produced from renewable energy.
For air temperature control, each office and laboratory is equipped with an electronic unit connected to a centralised Building Management System (BMS). Each control unit is equipped with a two ways valve electrically operated.
The whole building is equipped by a BMS that controls mechanical systems and electric systems. Both local and central level controls are connected to the BMS, having the goal of guaranteeing high comfort and low energy consumptions at the same time.

Structural design principles

The material selected for the floors rising above the ground level is steel, a material fully recyclable and of common use in Beijing, by means of which the supporting framework made of beams and pillars for the floors and the double skin glass shell was realized.
The concrete floors, after a technique frequently used in China, have been realized on-site and integrated with the system of steel beams. The side stability of the building is guaranteed by the cores of the starewells realized with braced frameworks of steel profiles.
Underground floors are entirely made of reinforced concrete, realized after a 8 x 8 m grid of pillars and with nervate bed foundations at 8 meters from the ground level.
The envelope of the building has four types of glazing surfaces, according to different orientation.

Photovoltaic systems

Photovoltaic systems consist of 190 modules, each with nominal power of 105Wp. The modules are assembled in 2 different fields having 95 modules each, over the terraces of the eastern and western wings of the building. The total nominal peak power of the plants is 19.95 KWp. The conversion of the DC power produced by the modules into AC power for the building appliances is obtained by means of 6 inverters. The parallel interconnection of the series is realized inside these inverters.

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