# ITALY

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## 1. ENERGY, ECONOMIC AND ELECTRICITY INFORMATION

### 1.1. General Overview

A republic of Southern Europe, Italy is a peninsula set in the Mediterranean Sea. It extends from the Alps, its northern border, southward for 960 kilometres; it has a maximum width of 240 kilometres. To the east lays the Adriatic Sea, to the south the Ionian Sea and to the west the Tyrrhenian and Ligurian seas. Starting from northwest and moving to northeast, Italy is bounded by France, Switzerland, Austria and the Republic of Slovenia. The Apennines, a recent mountain chain, created by the collision of the African and European plates, subject to frequent earthquakes, extends the length of the peninsula. There are few large catchment basins and only the Po basin is suitable site for modern nuclear power plants.

The peninsula comprises much of Italy and includes the independent republic of San Marino as well as the Vatican City. In addition to the continental part there are two big islands, Sicily and Sardinia. The total area is 301,260 square kilometres.

Italy is located in the temperate zone, the mainland climate varies from the north to the south; summer temperatures are relatively uniform in most cities and range on average between 23°C and 28°C, while winter temperatures range between 12°C and 17°C. The annual average rainfall, generally, does not exceed 1,000 mm.

In 2002, the population of Italy was about 58 million with the density of 192 people per square kilometre. Table 1 gives the statistical data until 2002. The capital and largest city is Rome which had a population of about 3 million in 2002. The country is composed of 20 regions, which are subdivided into 104 provinces.

TABLE 1. POPULATION INFORMATION

| | | | | | | | Growth rate (%/yr) |
|---|---|---|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2000 | 2001 | 2002 | 1990 To 2002 |
| **Population (millions)** | 54.1 | 56.5 | 56.7 | 56.8 | 56.9 | 57.3 | 0.1 |
| **Population density (inhabitants/km²)** | 178.6 | 187.3 | 189.3 | 191.0 | 190.9 | 190.8 | |

| | |
|---|---|
| **Predicted population growth rate (%) 2002 to 2010** | -1.9 |
| **Area (1000 km²)** | 301.3 |
| **Urban population in 2002 as percent of total** | 67.2 |

Source: IAEA Energy and Economic Database.

#### *1.1.1. Economic Indicators*

Table 2 shows the historical GDP data.

#### *1.1.2. Energy Situation*

Italy is poor in natural resources and depends heavily on imported energy supply. In 2000, about 83% of Italy's energy was imported. Natural gas is Italy's largest domestic source of energy with proven reserves of 9.1 EJ in 1996 (Table 3).

Italy's total primary energy consumption was 184.8 Mtoe in 2000, of which solid fuels accounted for 12.8 Mtoe, oil 91.3 Mtoe, natural gas 58.1 Mtoe, renewable sources (hydro, geo, wind, solar, biomasses) 12.8 Mtoe, and electricity net imports 9.8 Mtoe. Historical data are given in Table 4.

TABLE 2. GROSS DOMESTIC PRODUCT (GDP)

| | | | | | | Growth rate (%/yr) |
|---|---|---|---|---|---|---|
| | 1980 | 1990 | 2000 | 2001 | 2002 | 1990 To 2002 |
| **GDP (millions of current US$)** | 448,825 | 1,102,439 | 1,073,121 | 1,037,589 | 1,008,550 | -0.7 |
| **GDP (millions of constant 1990 US$)** | 881,351 | 1,102,439 | 1,288,494 | 1,315,168 | 1,342,540 | 2 |
| **GDP per capita (current US$/capita)** | 7,953 | 19,333 | 18,651 | 18,038 | 17,545 | -0.8 |

Source: IAEA Energy and Economic Database.

TABLE 3. ESTIMATED ENERGY RESERVES

| | Estimated energy reserves in (Exajoule) | | | | | |
|---|---|---|---|---|---|---|
| | Solid | Liquid | Gas | Uranium (1) | Hydro (2) | Total |
| **Total amount in place** | 0.84 | 2.56 | 7.26 | 2.62 | 32.78 | 46.05 |

*(1) This total represents essentially recoverable reserves.*

*(2) For comparison purposes a rough attempt is made to convert hydro capacity to energy by multiplying the gross theoretical annual capability (World Energy Council - 2002) by a factor of 10.*

Source: IAEA Energy and Economic Database.

## 1.2. Energy Policy

The last Energy Plan approved by the Government dates back to August 1998. It focused on a set of actions capable of yielding substantial results in terms of energy conservation, environmental protection, development of domestic energy sources, diversification of imported energy sources and their origins, and safeguarding the competitiveness of the production system. Since 1998, the Italian Government has issued no further comprehensive energy documents. A five-years nuclear moratorium, following a popular referendum, which took place in 1987, officially expired in December 1993, nevertheless the Government remains steadfast in excluding nuclear energy. Recently, a new State owned Company (SOGIN) got the assets constituted by the closed existing power stations (about 1,400 MW) and will take care of their decommissioning. A return to nuclear power, in Italy, is for the moment not foreseeable.

Italy's energy policy is currently driven by market liberalisation, transfer of relevant political and administrative decision-making powers to the regional authorities, diversification of supply sources, energy security, efficiency improvements and environmental protection. Italy has made significant progress in implementing electricity and gas market reforms and in restructuring its energy industry. The European Commission directives for electricity and gas market liberalisation have been transposed into legislation. Large state-owned energy companies began to be privatised and the government reduced its shares in both ENEL (electricity) and Eni (oil and gas). New institutions, including an energy sector regulator "Electricity & Gas Regulator" (AEEG), are now fully operational, which will ensure a much more market-oriented energy economy.

Italy ratified the Kyoto Protocol in June 2002 and on 19 December 2002 released the first national action plan for the reduction of greenhouse gas (GHG) emissions, the *Revised Guidelines for National Policies and Measures Regarding the Reduction of Greenhouse Gas Emissions*.

Diversification of energy sources is particularly challenging in this respect. Italy's energy mix is shifting from oil to more use of gas, with little probability of rapidly diversifying much further owing to the limited growth of renewable energy, local resistance to coal and the fact that the nuclear option was abandoned in 1987. Significant reliance on oil and gas, including from external supply sources, raises concerns about security of supply and the risk of high energy costs. Timely investment in energy production, transportation and interconnection is essential to secure energy supply and more active competition. Italy's high level of local resistance to new infrastructure is becoming increasingly serious in the context of the transfer of power to local authorities. Uncertainties regarding responsibilities for clearing new energy projects and complexity in the authorisation procedures are consequences of the legal changes initiated to enable decentralisation. From April 2002, the government introduced a fast track procedure for new electricity generating plants (Sblocca Centrali), thereby streamlining the decision-making process.

TABLE 4. ENERGY STATISTICS(*)

| | | | | | | | Average annual growth rate (%) | |
|---|---|---|---|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2000 | 2001 | 2002 | 1970 To 1990 | 1990 To 2002 |
| **Energy consumption** | | | | | | | | |
| - Total (1) | 4.68 | 6.06 | 6.95 | 7.85 | 8.13 | 8.35 | 1.99 | 1.55 |
| - Solids (2) | 0.43 | 0.54 | 0.63 | 0.61 | 0.61 | 0.61 | 1.95 | -0.26 |
| - Liquids | 3.32 | 3.91 | 3.77 | 3.59 | 3.66 | 3.81 | 0.64 | 0.10 |
| - Gases | 0.45 | 1.06 | 1.85 | 2.70 | 2.88 | 2.93 | 7.33 | 3.92 |
| - Primary electricity (3) | 0.49 | 0.54 | 0.70 | 0.96 | 0.99 | 1.00 | 1.85 | 2.97 |
| **Energy production** | | | | | | | | |
| - Total | 1.04 | 1.10 | 1.27 | 1.42 | 1.40 | 1.36 | 1.00 | 0.61 |
| - Solids | 0.06 | 0.06 | 0.05 | 0.06 | 0.06 | 0.06 | -1.23 | 1.97 |
| - Liquids | 0.07 | 0.08 | 0.20 | 0.19 | 0.18 | 0.17 | 5.42 | -1.08 |
| - Gases | 0.46 | 0.48 | 0.65 | 0.63 | 0.61 | 0.58 | 1.78 | -1.02 |
| - Primary electricity (3) | 0.45 | 0.48 | 0.37 | 0.54 | 0.55 | 0.55 | -0.98 | 3.42 |
| **Net import (Import - Export)** | | | | | | | | |
| - Total | 4.08 | 5.15 | 5.56 | 6.48 | 6.75 | 7.12 | 1.55 | 2.08 |
| - Solids | 0.38 | 0.49 | 0.60 | 0.57 | 0.60 | 0.64 | 2.37 | 0.44 |
| - Liquids | 3.71 | 4.11 | 3.78 | 3.72 | 3.71 | 3.72 | 0.09 | -0.13 |
| - Gases | | 0.55 | 1.18 | 2.19 | 2.44 | 2.76 | | 7.36 |

*(1) Energy consumption = Primary energy consumption + Net import (Import - Export) of secondary energy.*

*(2) Solid fuels include coal, lignite and commercial wood.*

*(3) Primary electricity = Hydro + Geothermal + Nuclear + Wind.*

*(*) Energy values are in Exajoule except where indicated.*

Source: IAEA Energy and Economic Database.

## 1.3. The Electricity System

### *1.3.1. Structure of the Electricity Sector*

In 1962, the electric sector was nationalized by Law 1643 of 6 December 1962. ENEL (Ente Nazionale per l'Energia Elettrica, Italian Electricity Generating Board) was established to be wholly responsible for electricity production and transmission, and partially responsible for distribution of electric energy.

Over the following three decades, the structure of the Italian electricity sector - in terms of production, transmission and distribution – was organized along the following model: a large, nation wide company: ENEL; a number of municipal utilities, namely in the large cities like Rome, Milan, Turin; and a large number of industrial autoproducers.

Starting from the early '90s, many changes have been developed in the Italian electricity sector and the consequences begin to appear.

By Decree No. 333 of 11 July 1992, the Government decided to privatize some state-owned industrial and commercial companies. The new companies issued shares for a total value equal to the net fixed assets given in the last balance sheet. The shares have been allocated to the Treasury and the revenue obtained by their sale will be used to reduce the national debt and to balance the Government's books. Thus, in August 1992, ENEL became a joint-stock company (ENEL S.p.A.) with its shares in the hands of the Treasury. In November 1995 the law setting up the Independent regulatory Authority has been approved, and the Authority has been operational since the beginning of 1997. In December 1995 The Ministry of Industry issued the new concession to Enel SpA.

In March 1999, a legislative Decree ("Bersani" Decree) was issued, for the restructuring and liberalization of the Italian electricity sector: the purpose of the Decree is both to reach a sufficiently large liberalization and to guarantee such general economic interest as, for instance, a universal service, tariff equalization, the development of renewable sources.

According to the "Bersani" decree, Enel SpA begun a process of complete reorganization. Enel is now an holding, whose shares are for 60% property of the Ministry of Economy and Finance (former Ministry of Treasury). The balance of 40% is already on the stock market. As for generation, Enel has subdivided its generation capacity in a few companies (Gen.Co. Generation Companies), with the perspective of reducing its generation share in the Italian market accordingly to the European directive. Companies Elettrogen (5720 MW), Eurogen (7000 MW), and Interpower (2600 MW) have already been sold to private operators. Two other companies in the holding are dedicated to distribution (one company for the captive market and one for the free market). Many others stock companies exist in Enel group for other business such as engineering, lighting, water management, and other for different industrial services.

The government introduced an ambitious measure to cap the incumbent's market share to less than 50%. This has enabled the entry of a number of new market participants. The electricity market has been liberalised up to 70% in several phases, with full liberalisation planned for 2007.

Transmission networks have been legally unbundled and, in April 2000, a Transmission System Operator established (GRTN) (Gestore della Rete di Trasmissione Nazionale - Italian Independent System Operator).

The activities of GRTN concern electricity transmission on the high- and extra-high voltage grid (national transmission grid) that it operates under exclusive rights ("concession"). This responsibility is fulfilled through dispatching, i.e. the co-ordinated operation of power plants, national transmission grid, connected grids and ancillary services.

The shares of GRTN are held by the Ministry of Economy and Finance, exercising the shareholder's rights jointly with the Ministry of Production Activities, which also issues strategic and operational guidelines for GRTN.

GRTN set up two companies, of which it is the sole shareholder: **AU** (Acquirente Unico) and **GME** (Gestore del Mercato Elettrico). AU plays the role of single buyer of electricity for the customers of the *captive market*, on the basis of criteria of service continuity, security, efficiency and non-discrimination of customers (also from the standpoint of tariffs) throughout the country. Captive customers are households and small businesses that are not entitled to choose their supplier because the value of their power consumption lies below a specified threshold. AU has the task of purchasing electricity and of reselling to distributors the portion allocated to the captive market, in compliance with the directions of the Electricity & Gas Regulator (AEEG). The date upon which AU will acquire the responsibility of power procurer for the captive market will be set by a decree to be issued by the Minister of Production Activities. Until that time, Enel Spa will ensure electricity supply to distributors under the applicable conditions and contracts.

GME is a company with the task of organising and managing the electricity market, on the basis of transparency and objectivity criteria, so as to foster competition between producers and ensure the availability of an adequate power reserve.

To this end, GME lays down the rules of the market, which are approved by a decree of the Minister of Production Activities, after seeking the opinion of the Electricity & Gas Regulator (AEEG). GME will have the task of managing the *Power Exchange* , where offers/bids for purchase and sale of power and of ancillary services will be traded.

*1.3.2. Decision Making Process*

New generation capacity will be built according to the licensing procedure: producers wanting to operate on the free market will apply for the authorization. In order to encourage the use of renewable sources, operators producing more than 100 GW·h/year (coming from non renewable sources) will be obliged as of 2001 to insert a quota of energy into the grid produced with renewable sources equal to 2% of the amount exceeding 100 GW·h.

From April 2002, the government introduced a fast track procedure for new electricity generating plants (Sblocca Centrali),thereby streamlining the decision-making process.
From January 2003, no producer or operator is allowed to generate or import more than 50% of the total electric power generated and imported in Italy.

*1.3.3. Main Indicators*

Italy's total gross output capacity of electricity generating plants in 2001 amounted to 78.790 MW: thermal plants 56,800 MW, hydroelectric 20,750 MW, geothermal 573 MW and 670 MW renewable sources (Table 5). Total gross electricity production in 2001 was 279.630 GW·h., including wind and photovoltaic for about 0.8 TW·h. High voltage transmission lines, connecting power plants with the distribution system, are mainly based on 380 kV lines and 220 kV lines.

In 2000, the electricity demand on the national grid was 305.4 TW·h with a per capita demand of 5,154 kWh. In 2000, electricity's share in gross domestic energy demand was 35.4%. Energy related ratios are given in Table 6.

TABLE 5. ELECTRICITY PRODUCTION AND CAPACITY

| | 1970 | 1980 | 1990 | 2000 | 2001 | 2002 | Average annual growth rate (%) 1970 To 1990 | Average annual growth rate (%) 1990 To 2002 |
|---|---|---|---|---|---|---|---|---|
| **Electricity production (TW.h)** | | | | | | | | |
| - Total (1) | 116.83 | 183.46 | 216.89 | 276.63 | 278.99 | 283.7 | 3.14 | 2.20 |
| - Thermal | 70.22 | 133.35 | 178.59 | 220.47 | 219.38 | 229.8 | 4.78 | 1.91 |
| - Hydro | 40.70 | 45.23 | 35.08 | 50.90 | 53.92 | 48.1 | -0.74 | 3.27 |
| - Nuclear | 3.18 | 2.21 | | | | | | |
| - Geothermal | 2.73 | 2.67 | 3.22 | 4.71 | 4.51 | 4.99 | 0.84 | 3.71 |
| **Capacity of electrical plants (GWe)** | | | | | | | | |
| - Total | 30.41 | 46.82 | 56.55 | 85.05 | 86.64 | 88.81 | 3.15 | 3.83 |
| - Thermal | 16.15 | 29.15 | 37.28 | 62.04 | 63.47 | 65.21 | 4.27 | 4.77 |
| - Hydro | 13.34 | 15.83 | 18.77 | 22.19 | 22.22 | 22.63 | 1.72 | 1.57 |
| - Nuclear | 0.55 | 1.42 | | | | | | |
| - Geothermal | 0.37 | 0.43 | 0.50 | 0.59 | 0.61 | 0.63 | 1.50 | 1.95 |
| - Wind | | | | 0.23 | 0.35 | 0.35 | | |

*(1) Electricity losses are not deducted.*

Source: IAEA Energy and Economic Database.

TABLE 6. ENERGY RELATED RATIOS

| | 1970 | 1980 | 1990 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| **Energy consumption per capita (GJ/capita)** | 87 | 107 | 122 | 136 | 141 | 145 |
| **Electricity per capita (kW.h/capita)** | 2,159 | 3,211 | 4,123 | 5,347 | 5,414 | 5,470 |
| **Electricity production/Energy production (%)** | 108 | 160 | 165 | 187 | 193 | 199 |
| **Nuclear/Total electricity (%)** | 3 | 1 | | | | |
| **Ratio of external dependency (%) (1)** | 87 | 85 | 80 | 83 | 83 | 85 |
| **Load factor of electricity plants** | | | | | | |
| - Total (%) | 44 | 45 | 44 | 37 | 37 | 36 |
| - Thermal | 50 | 52 | 55 | 41 | 40 | 39 |
| - Hydro | 35 | 33 | 21 | 26 | 26 | 26 |
| - Nuclear | 66 | 18 | | | | |

*(1) Net import / Total energy consumption.*

Source: IAEA Energy and Economic Database.

2. NUCLEAR POWER SITUATION

## 2.1. Historical Development and current nuclear power organizational structure

### *2.1.1. Overview*

Italy was among the first countries in the world to use nuclear technology for civil power generation purposes only. The Italian history of nuclear technology development can be split into three major periods:

i) pioneering period from 1946 to 1965 during which the private industry played a fundamental role;
ii) planning period from 1966 to 1987, during which the Government planned nuclear development;
iii) post referenda period from 1988 onward, which is characterized by the efforts to abandon nuclear energy production.

*Pioneering Period*

In November 1946, CISE (Centro Informazioni, Studi ed Esperienze) was founded, with the participation of the elite post-war Italian industries (Edison, Montecatini, FIAT) and some of the most prominent Italian nuclear scientists. Early on, the purpose of CISE was to lay down the foundations of civil nuclear engineering and, later on, to design a natural uranium fuelled, heavy water moderated test nuclear reactor.

In June 1952, the Government established CNRN (Comitato Nazionale per le Ricerche Nucleari), an agency in charge of developing and promoting nuclear technology. In August 1960, the agency was reorganized and renamed CNEN (Comitato Nazionale per l'Energia Nucleare).

In October 1958, the construction of the country's first nuclear power plant, Latina, began. This 200 MW(e) gas-graphite reactor (Magnox, from magnesium alloy used in the fuel cans) was connected to the electric grid in May 1963. It was ordered by SIMEA, an ENI[1] (Ente Nazionale Idrocarburi) subsidiary, and contracted from the Nuclear Power Plant Company (NPPC) of the UK. The United Kingdom's Atomic Energy Authority was to offer support for the safety aspects.

In November 1959, construction work for the Garigliano nuclear power plant began. A Boiling Water Reactor prototype was ordered by SENN (Societa Elettro Nucleare Nazionale) from the International General Electric. In January 1964, Garigliano 150 MW(e) reactor started operation.

The Trino Vercellese nuclear power plant, a Westinghouse PWR with two separate turbine systems, was ordered by SELNI (Societa Elettro Nucleare Italiana), a subsidiary of the Edison group. Construction for the 260 MW(e) Trino Vercellese began in August 1961. It entered commercial operation in October 1964.

A general rule, Law 1860, to regulate peaceful use of atomic energy was issued for the first time in December 1962. This law assigned CNEN the role of the nuclear Regulatory Body and foresaw the issuance of a subsequent law for radioactive protection of population and workers.

In February 1964, the Italian Government issued a complete set of Regulations (D.P.R. 230) to cover into details the different aspects of nuclear safety and radiation protection. CNEN was confirmed as the official Regulatory Body. However, this responsibility created an inherent conflict of interests between its role as a public promoter of nuclear technology and as a Regulator. The safety criteria during the period were adopted from countries exporting nuclear technology (mainly the UK and the USA).

[1] Italian Hydrocarbons Board

In 1962, after a long political struggle, the electric sector was nationalized and ENEL was established as the sole utility. In 1964, the ownership of Latina nuclear power plant was transferred to ENEL, and, in 1966, also the Garigliano and Trino units were transferred to ENEL, hence closing the first period of the Italian nuclear history.

*Planning Period*

In December 1966, ENEL announced a huge nuclear programme forecasting 12,000 MW of nuclear power by 1980. A year later, in 1967, CIPE [2] (Comitato Interministeriale per la Programmazione Economica) - a Committee in charge of co-ordinating the activities of Ministries involved in the country's economic planning and of defining the nuclear programme of ENEL - reorganized the nuclear sector. Among the most important actors (all state-owned companies) were:

i) ENEL, which maintained its position as the sole utility;
ii) ENI, which was in charge of nuclear fuel;
iii) ANSALDO, which was in charge of collaborating with foreign supplier(s) and later became the Italian nuclear components supplier.

In 1967, an agreement was signed by CNEN and ENEL for developing an Italian version of the Canadian CANDU. This reactor type, called CIRENE, was designed to use heavy water as moderator and boiling water as coolant. In 1972, ANSALDO got an order to build a 40 MW(e) prototype close to the Latina nuclear power plant. CISE actively participated in the design and construction of the CIRENE reactor, which, however, never became operational due to technical problems and the lack of economic resources. Its construction was finalized only in 1988.

In 1969, ENEL decided to build a BWR (G.E. BWR 4, Mark 2) on the site of Caorso; one year later ANSALDO, in a joint venture with G.E., officially received the order. The Caorso site construction began in 1970. After several delays in implementing improvements in the suppression pool and bolstering thermal fuel performance, this 860 MW(e) unit finally started commercial operation in 1981.

In 1974, following the Yom Kippur War and the consequent oil crisis, the Ministry of Industry, Commerce and Crafts (hereafter referred to as Ministry of Industry) approved a National Energy Plan that foresaw the construction of 20 nuclear power plants in order to reduce the contribution of oil on the Italian energy balance. The main effort during that period was to achieve a certain level of technological independence from the American licenser(s). Political indecision led the industry to spread technical and economic resources over five different reactor types; namely, the BWR of General Electric, the PWR of Westinghouse and Babcock types, the CANDU of AECL, and the indigenous CIRENE.

To attain the goals of the new energy plan, the Italian government in 1973, joined the EURODIF consortium. AGIP Nucleare, a subsidiary of ENI, and CNEN were in charge of providing the country with enriched uranium for fuel fabrication. Meanwhile, in 1972, ANSALDO -in a joint venture with G.E.- completed the Fabbricazioni Nucleari (Bosco Marengo) to manufacture the fuel elements for the future BWR's. The plant can produce 100 tons of fuel annually. It entered in operation in 1976 and has produced more than 500 tons of fuel for the Italian nuclear power stations and Leibstadt nuclear power station in Switzerland.

Later, in December 1973, three major European utilities signed an agreement to build a Superphenix, 1200 MW(e) fast breeder reactor in France. A second smaller station was planned in Federal Republic of Germany. The three original partners were Electricité de France (EdF), ENEL and Rheinisch Westfalisches Elektrizitätswerk (RWE). Subsequently RWE was substituted by Schnell-Bruter Kernkraftwerkgesellschaft (SBK), a joint enterprise of RWE, Belgian and Dutch

[2] Interministerial Committee for Economic Planning

utilities and, to a lesser extent, the British Central Electricity Generating Board (CEGB). Under the terms of this agreement the NERSA company was created in 1974 to undertake the construction of the Creys-Malville station. EdF's share of NERSA was 51%, ENEL had 33% and SBK 16%. Preliminary work on the Creys-Malville site started in December 1974. The fist concrete was laid in December 1976. The reactor began operation in January 1986. Earlier, in 1983, construction had began for PEC (Prova Elementi di Combustible) for testing fast breeder fuel elements. This was intended to strengthen Italy's participation in the Superphenix venture.

In 1976, Montalto di Castro was selected as the site for two new BWR's (G.E. BWR 4, Mark 3). The site permit was issued in 1979, exactly one month before the Three Mile Island incident. This along with the active opposition of the environmental movements, delayed the implementation of the energy plan. Moreover, ENEL faced increasing difficulties with its nuclear power stations and conventional power plants with the construction of transmission system. During the 1980's, the nuclear option became one of the major political issues, almost completely halting all nuclear activities, despite the commitments of several energy plans.

The new National Energy Plan of 1982 reflected mixed attitudes. It called for two nuclear units at Montalto di Castro and six other units on three different sites (Piemonte, Lombardia and Puglia). The plan also identified the development of the so-called PUN[3] (Progetto Unificato Nazionale), a Westinghouse pressurized water reactor as the final reactor type for the country. The most important characteristic of PUN design was to standardize nuclear plant design and construction. ENEA[4] (Ente Nazionale per la ricerca e lo sviluppo dell'energia nucleare e delle Energie Alternative), formerly CNEN, was split into two major branches: ENEA responsible for research and promotion of nuclear technology; and, ENEA/DISP[5], an independently acting nuclear Regulatory Body.

*Disengagement Period*

In 1986, a few months before the Chernobyl nuclear disaster, CIPE reaffirmed its commitment for the two BWR units at Montalto di Castro and for the six PUN type pressurized water reactors. However, the impact of the Chernobyl disaster on public opinion was enormous and a general debate on the implications of the use of nuclear energy inflamed the contest in the political arena. In November 1987, three referenda were passed essentially stopping any activity in the nuclear sector.

In December 1987, CIPE halted construction of the Montalto di Castro and Piemonte plants. These were the only two sites where construction work was effectively in progress. A nuclear moratorium period of five years became effective.

In June 1988, the Government, by Decree Nos. 230 and 324, ended all nuclear construction. The Caorso reactor, which was shut down in October 1986 for the annual refuelling remained in cold shut down for a complete safety review and assessment. In 1989, an OSART (Operational Safety Assessment Review Team, under the aegis of IAEA) inspection of the Caorso plant was conducted; but, despite of positive results of both reviews, CIPE decided, in July 1990, to close down the plant. At the same time Trino nuclear power plant was closed. The remaining units of Garigliano and Latina had already been closed down in August 1978 and November 1986, respectively.

At the same time ENEA decided to close down a number of facilities relevant to the fuel cycle: IFEC (Impianto di Fabbricazione Elementi di Combustibile), EUREX (Enriched Uranium Extraction), ITREC (Impianto di Trattamento e Rifabbricazione Elementi di Combustibile) and the plutonium plant at its Casaccia Centre. In effect, Italy is currently inactive in the nuclear energy sector.

[3] Standard Nuclear Plant Project.
[4] Italian Commission for research and Development of Nuclear and Alternative Energy Resources, set up under Act No. 84 of 5 March 1982 to reorganise CNEN.
[5] Directorate for Nuclear Safety and Health Protection.

*2.1.2. Current Organizational Chart(s)*

In the context of the privatization and of the liberalization of the electric energy market, and accordingly to a legislative Decree (Decreto legislativo n° 79 , 16 March 1999) all Enel's liabilities and assets (and all capabilities and resources) connected to nuclear power have been assigned to a newly established company, named SO.G.I.N. (Società Gestione Impianti Nucleari, hereafter Sogin); Sogin is operational since November 1st, 1999; its shares have been transferred in 2000 to the Ministry of Treasure (now Ministry of Economy and Finance); nevertheless, Sogin will act accordingly to guidelines issued by the Ministry of Industry (now Ministry of Productive Activities).

The mission of Sogin covers:

- the decommissioning of the NPPs in Italy;
- the decommissioning of the fuel cycle plants, which are property of ENEA and Fabricazioni Nucleari (FN), but whose licenses have been transferred to SOGIN;
- the disposal of the low and intermediate radioactive wastes resulting from the past operation and from the dismantling activities;
- the temporary storage of the high level wastes (resulting from the reprocessing of the fuel) and of the no reprocessed spent fuel.

Authorisations are granted by the Ministry for Productive Activities (MAP, formerly Ministry of Industry), on the basis of the technical advise of the National Agency for Environmental Protection and Technical Services (APAT).

APAT is a technical body governed by public law with operational and administrative autonomy under the supervision of the Ministry of Environment. It is responsible for the regulation and supervision (by inspection) of nuclear installations in the matter of nuclear safety and radiation protection..

The Technical Commission for Nuclear Safety and Health Protection from Ionising Radiations, is an advisory body of APAT, which gives its technical advice on question of safety and health protection in relation to the main stages in the licensing procedure. It is composed of experts from ENEA, APAT, and various Ministries,

The Ministry for the Environment is the authority responsible for the decision in the matter of environmental compatibility of nuclear projects, including decommissioning of nuclear power stations and other reactors.

## 2.2. Nuclear Power Plants: Status and Operations

TABLE 7. STATUS OF NUCLEAR POWER PLANTS

| Station | Type | Capacity | Operator | Status | Reactor Supplier |
|---|---|---|---|---|---|
| CAORSO | BWR | 860 | Sogin[1] | Shut Down | AMN/GETS |
| ENRICO FERMI (TRINO) | PWR | 260 | Sogin[1] | Shut Down | WEST |
| GARIGLIANO | BWR | 150 | Sogin[1] | Shut Down | GE |
| LATINA | GCR | 153 | Sogin[1] | Shut Down | TNPG |

| Station | Construction Date | Criticality Date | Grid Date | Commercial Date | Shutdown Date |
|---|---|---|---|---|---|
| CAORSO | 01-Jan-70 | 31-Dec-77 | 23-May-78 | 01-Dec-81 | 01-Jul-90 |
| ENRICO FERMI (TRINO) | 01-Jul-61 | 21-Jun-64 | 22-Oct-64 | 01-Jan-65 | 01-Jul-90 |
| GARIGLIANO | 01-Nov-59 | 05-Jun-63 | 01-Jan-64 | 01-Jun-64 | 01-Mar-82 |
| LATINA | 01-Nov-58 | 27-Dec-62 | 12-May-63 | 01-Jan-64 | 01-Dec-87 |

[1]Sogin since November 1st, 1999; before, the operator was ENEL.
Source: IAEA Power Reactor Information System as of 31 December 2002; Sogin.

## 2.3. Supply of NPPs

Due to the historical development of nuclear technology in Italy in the pioneering period, it was not possible to develop separate organizations for the roles of architect engineer and nuclear steam systems supplier. Both activities were performed mainly by foreign companies. For example, for Caorso nuclear power plant the supplier was a joint venture of ANSALDO and G.E. (AMN/GETS), while the architect engineering services were provided by Gibbs & Hill of the U.S. For PUN, it was foreseen that ENEL would have covered the role of architect engineering, and ANSALDO would have been the nuclear supplier.

At present, ANSALDO participates in a joint venture with AECL for construction of five CANDU reactors in Cernovoda, Romania (the first of them is now operating)

Sogin is also present in the international market offering mainly engineering and consultancy services for refurbishing of power plants, for on site assistance programmes and for decommissioning activities. At present, Sogin is participating in PHARE and TACIS programmes: it is since 1997 leader in the On Site Assistance project of the Medzamor plant (Armenia); as a partner of EDF it is operating for safety improvements of Aktau (Kazakistan) and Beloyarsk (Russia) fast breeder reactors; other services have been granted in other eastern countries and in the field of training. Sogin also gives consultancy service to ENEL regarding “due diligence” activities on european electric market.

## 2.4. Operation of NPPs

Since 1962, ENEL has been the only utility owning and operating nuclear power reactors. ENEL has also acted as a maintenance company with several other private or state-owned companies (ANSALDO, Carlo Gavazzi, Fochi, Belleli, FIAT, etc.). For instance, half of the outage services at Caorso NPP were performed by the plant personnel and other half by external contractors. For training nuclear operators, ENEL established, in the 1980's, a training centre in Piacenza equipped with a full scale BWR simulator. Of course, with the stop of any activity in the nuclear sector, the centre is not operating any more.
Now Sogin cares about post operation activities of NPPs to be decommissioned

## 2.5. Fuel Cycle and Waste Management

### *2.5.1. Uranium enrichment and fuel fabrication*

In Italy, there are no facilities for enriching Uranium. Several installations have the capability to manufacture fuel elements. However, at the present time all are closed.

### *2.5.2. Fuel transportation*

At the moment, fuel transportation is made with the purpose of sending the fuel to BNFL (England) for reprocessing. Transport is made with qualified containers and only by authorized carriers. The authority responsible for issuing freight licences is the Ministry of Industry, after APAT ( see section 5.1) has given its technical assessment. The rules regulating transport of radioactive material come from IAEA's Safety Series No. 6, and are in accordance with international regulations enacted by ICAO, ADR, RID and IMO.

### *2.5.3. Spent fuel disposal and storage*

In the middle of the 90ties, Enel has decided to terminate nuclear fuel reprocessing, on the basis of an economical and technical evaluation, and to proceed with interim dry storage of the remaining spent fuel of light water reactors. At the moment, only the fuel related to contracts already issued, is sent to BNFL for reprocessing. It was in fact recognized that, in the light of the Italian situation, reprocessing would not have brought important advantages in term of final disposal, since VHLW would have to be disposed anyway together with other reprocessing generated wastes; moreover, the waste form would not have implied specific advantages in term of final disposal, where only geological barriers could be credited. The strategy now is to store, in dual purpose (transport and storage) metallic cask, the fuel elements in interim storages on nuclear sites. When the national repository for radioactive waste will be in operation, the storage will be continued there, waiting for a final (geological) disposal.

### *2.5.4. Waste management and disposal*

The sources of radioactive waste in Italy include the power plants formerly operated by ENEL, the fuel cycle plants operated by Fabbricazioni Nucleari S.p.A., ENEA research laboratories and experimental facilities, and non-energy applications (e.g., biomedical and other uses).

Criteria applicable to the classification, treatment and disposal of radioactive waste are set forth in ENEA/DISP's Technical Guide No. 26, issued in May 1988 and updated in 1997. These rules allow above ground disposal of treated low-level waste (Categories I and II) and prescribe suitable final disposal solutions (such as deep disposal) for high-level waste (Category III).
As for categories I and II, solid low-level waste is to be super-compacted and cemented. Liquid low-level waste is to be cemented in containers suitable for above ground storage.

It is a governmental commitment the definition of guidelines and of a regulatory framework for the management of radioactive wastes: in this view a National Operator is to be created and appointed

for the management of all existing and future wastes; in the meantime, a procedure has been initiated by the government in order to select the site for the final repository for the second category wastes: the repository is at present scheduled to be operating early in 2009. the Government issued a project of law that foresees the procedures for the establishment of the body that will care the siting, the construction and the operation of the repository. Waiting for the constitution of the national operator, Sogin has provided strategies for the temporary storage on their sites of the produced wastes;. APAT is responsible for licensing aspects.

### 2.6. Research and Development

Nuclear research is conducted by several agencies, institutions and universities. The leading agency for applied nuclear research is ENEA with its Energy Research Centre (CRE) at Casaccia, near Rome. Theoretical research in the nuclear field is performed mainly under the aegis of CNR[6] (Consiglio Nazionale delle Ricerche) and INFN[7] (Instituto Nazionale di Fisica Nucleare) in its four main laboratories - Laboratori Nazionali di Frascati, Laboratori Nazionali di Legnano, Laboratori Nazionali del Sud and the new Laboratori Nazionali del Gran Sasso.

In nuclear engineering, the universities with degree programmes are the Università di Roma (power plant engineering), the Università di Pisa (safety assessments), and the Politecnico di Milano (plant engineering and probabilistic safety studies).

Some research activities, experiments and studies, mainly in connection with the above universities and agencies, are still performed at the facilities equipped with research reactors as shown in Table 8.

TABLE 8. RESEARCH REACTOR FACILITIES

| SITE | POWER | OPERATOR | STATUS |
|---|---|---|---|
| Bologna | 100 We | ENEA/RB3 | In operation |
| Palermo | 20 We | University of Palermo | not operating |
| Roma (Casaccia) | 1 MW | ENEA/TRIGA | in operation |
| Roma (Casaccia) | 5 kW | ENEA/TAPIRO | In operation |
| Pavia | 250 kW | University of Pavia | in operation |
| Ispra | | CCR | Not operating |
| Ispra | | CCR | Not operating |
| Milano | | CESNEF L54M | Not operating |
| Padova | | University of Padova | In operation |
| Pisa | | CISAM | Not operating |

Source: Country Information.

### 2.7. International Co-operation and Initiatives

Italy and Russia signed in 2003 an agreement allocating 360m euros about cooperation in the field of nuclear submarines dismantling and safe handling of spent nuclear fuel and radioactive waste. The agreement includes projects on nuclear submarines, nuclear surface ships and service ships dismantling, reprocessing, transportation and storage of radioactive waste, creation of nuclear sites physical protection system, radiation sites rehabilitation, creation infrastructure for nuclear submarines dismantling. The Russian Atomic Ministry and the Italian Ministry of Productive Activities are responsible for the projects. The agreement is valid for 10 years, and extends automatically for 2 years more if the parties do not cancel the agreement before its expiry.

[6] Italian National Research Council
[7] Italian National Institute for Nuclear Physics

Italy participates in several international co-operative projects developed under the aegis of the European Community, NEA/OECD and the International Atomic Energy Agency. In this setting two important research centres must be pointed out: the Joint Research Centre of Ispra [8] and the International Centre for Theoretical Physics in Trieste, a branch of IAEA. APAT is participating in the PHARE and TACIS programmes of assistance to Central Europe and CIS countries. Sogin is also deeply involved in these programmes

In the area of nuclear safety and environmental protection, bilateral agreements have been signed with NRC (USA), NII (UK), CSN (Spain), N.N.S.A.(China), and D.S.I.N (France).

Some noteworthy activities in progress are: in nuclear fusion field, participation in the Joint European Torus project.

## 3. NATIONAL LAWS AND REGULATIONS

### 3.1. Safety Authority and the Licensing Process

Authorisations related to nuclear and radioactive installations are granted by the Ministry for Productive Activities (hereafter called MAP), on the basis of the technical advise of the National Agency for Environmental Protection and Technical Services (hereafter called APAT).

APAT (previous ENEA-DISP) is the Agency which carries out technical and scientific activities of national interest related to the protection of the environment, the defence of the water and territory resources. It has operational and administrative autonomy under the directives and the control of the Ministry of Environment.

For all nuclear activities, APAT acts as the technical body of MAP. Its responsibilities for the licensing process of nuclear installations include:

- assessment of the safety analysis carried out by the operating organisation
- inspection of equipment and materials during the design, construction and operational phases for the systematic verification of facility operation safety
- enforcement action to remedy any failure to meet both the licensing conditions and any safety operation criteria

The Technical Commission for Nuclear Safety and Health Protection from Ionising Radiations (hereafter called Technical Commission), is an Advisory Body of APAT, which gives its technical advice on question of safety and health protection in relation to the main stages of the licensing procedure. It is composed of experts from ENEA, APAT, and various Ministries,

The Ministry of the Environment is the authority responsible for the decisions in the matter of environmental compatibility of nuclear projects, including decommissioning of nuclear power stations.

#### Licensing procedures

Construction, operation and decommissioning of Nuclear Power Plants are governed by Act 393 of 23 August 1975 and D.Lgs. 230/95.

[8] Reactor Safety, Fusion Technology (with the European Tritium Handling Laboratory) and Advanced Materials are only some of the activities performed in the Centre. Another European research centre, in which Italy has a quota of 28%, is CERN (Consiglio Europeo per la Ricerca Nucleare) in Switzerland.

**Siting.**

Act No. 393/75 lays down a special administrative procedure for the preventive selection of the site, giving the Regions a large measure of responsibility for environmental protection and land use planning.

In accordance with this procedure, the Inter-ministerial Committee for the Economic Planning (CIPE), after consultation with APAT (previous ENEA-DISP) and in agreement with the Inter-regional Advisory Commission made up of the Presidents of the regional governments, decides on the Regions where nuclear power plants can be constructed. At the close of this first phase, each concerned Region has to indicate at least two areas in its territory where nuclear power plants might be sited.

Once the areas have been selected, the utility is given permission by MAP to proceed with all investigations that are needed to determine whether the areas selected are technically suitable and to decide which area it would propose for the installation. The utility has to submit a detailed report on the proposed site to MAP, to the concerned Regions and to APAT, containing a detailed analysis of the features of the site important from the nuclear safety and health protection standpoints.

The report is revised by APAT, which, after consultation with Ministries concerned (Interior, Employment, Public Works, Health and Environment), and the acquisition of the advice of the Technical Commission, draws up a technical report that is forwarded to MAP.

This technical phase is followed by a decision making phase culminating in a final choice of the site by the region, which is communicated to MAP.

Once the site has been approved, MAP authorises the utility to begin preliminary site preparation under the control of APAT.

From this point on, the licensing procedure continues along the lines set out in D.Lgs. 230/95.

**Construction**

The utility submits the general design (site and plant) and the preliminary Safety Report to MAP and to APAT. The documents must also include a Preliminary Study on the treatment and disposal of radioactive waste.

APAT draws up a technical report, which is forwarded to MAP, and to the concerned Ministries (Interior, Employment, Public Works, and Public Health) for their comments, which are forwarded to APAT. The Agency, after consultation of the Technical Commission, gives the MAP its final evaluation concerning the grant of the construction permit.

Before the permit is granted, the applicant must submit to APAT for approval a list of those parts of the installation relevant for nuclear safety and health protection, whose project must be approved by APAT prior to their fabrication and assembly. Also the study on treatment and disposal of radioactive waste must be handed to the European Commission, in accordance with section 37 of the EURATOM Treaty.

**Operation.**

Two series of tests - non nuclear and nuclear - must be successfully carried out before the commissioning of the installation.

Before the execution of nuclear tests, the operator must submit a set of safety a managerial documents (Final Safety Report, operating procedures, proposal of technical Specifications, etc.). The program of nuclear tests is approved by MAP after consultation with the Technical Commission. Such approval is subject to the Ministry of the Interior's approval of the emergency plan for safety measures in case of an accident.

The operating license is granted in successive stages by Decrees of MAP and includes the technical requirements specified by APAT.

**Decommissioning**

Decommissioning activities are regulated by articles 55, 56 and 57 of Legislative Decree n. 230/95. They must be authorised by MAP after a hearing with the Ministries of the Environment, Internal Affairs, Work, and Health, together with the interested region and APAT. This authorisation may be granted for single intermediate phases with respect to the last status of the facility.

The subdivision into intermediate phases has to be justified as a part of a global plan of decommissioning, to be attached to the request of authorisation connected to the first phase.

For each decommissioning phase, the activities to be performed have to be described, together with their safety, environmental and radiation protection implication as well as the initial and final state of the site and the solution envisaged for waste management and waste destination. The identification and analysis of possible hazard and of accident scenarios for each phase of decommissioning must be addressed in the application, together with implication for the outside emergency plan and proposal for its updating.

All decommissioning activities must be performed complying with conditions and technical specifications laid down in the decommissioning licence. Systems, components and equipment relevant to safety and radiation protection are subject to a general regime of technical specifications and surveillance tests, either specified in the decommissioning licence or, possibly, in the operation licence for the section still in force. APAT supervises decommissioning operations and carries out inspections to verify compliance with specifications concerning safety and radiation protection.

### 3.2. Main National Laws and Regulations in Nuclear Power

The system for licensing nuclear installations is governed by the following Laws and regulations.

- Law no. 1860 of 31st December 1962, which is the Basic Act on the peaceful uses of nuclear energy. The Law has been amended by the President's Decree no. 1704 of 30 December 1965, and by the President's Decree no. 519 of 10 May 1975. The Law regulates all activities connected with the peaceful uses of nuclear energy. Excluded from the scope of the Law are the nuclear installations for the generation of electricity, which are governed by the procedure lay down in Legislative Decree no. 230/95.
- Legislative Decree no. 230 of 17 March 1995, which replaced the previous DPR n°185 issued in 1964. Its provisions on nuclear safety and radiation protection apply to all practices involving an ionising risk, including the construction, operation, and decommissioning of nuclear plants. The Decree has been amended by:
  - Legislative Decree no. 241 of 26th May 2000, which has transposed European Union Directive 96/29/Euratom laying down basic safety standards for the radiation protection of workers and the public;
  - Decree no. 257 of 9th May 2001, which modifies some details concerning notification and authorisation of non nuclear installations where ionising radiation is used for industrial, research and medical purposes.

In addition to the provisions of Presidential Decree No. 230, APAT publishes Technical Guides, which outline the safety criteria and license application formats. These guides are prepared for nuclear operators and are informational in nature. Their purpose is to provide a better understanding of the controls exercised by APAT in matters of safety and health protection.

4. CURRENT ISSUES AND DEVELOPMENTS ON NUCLEAR POWER

## 4.1. Energy Policy

The future of the nuclear sector remains uncertain pending development and acceptance of the new generation of enhanced safety reactors, even if, after the recent black-out that occurred in Italy, a certain new consideration about nuclear energy raised out in public opinion.

Main nuclear policy issues relate to the decommissioning and waste disposal facilities. The ultimate strategic goal, for the former, is unrestricted site release.

On 14 December 1999, the Italian Government, with an announcement of the Ministry of Industry, has outlined strategic choices and plans to manage the problems connected with the closure of all nuclear activities in the country. These guidelines have been submitted to the Parliament, even if a wide consensus both on political and technical bodies has raised and a high level of confidence about their confirmation should be considered.

The ministry statement outlines three main goals:

- treatment and conditioning, within a 10 year period, of all liquid and solid radwaste currently in on-site storage, mostly issued from the operation of the plants, with a view to subsequent transport to a national waste repository;
- Site selection and construction of a national repository for low and intermediate level wastes, also within 10 years; the same site would be used for temporary storage of high level long lived wastes, particularly spent fuel and wastes resulting from reprocessing: the final selection of a site for waste disposal facilities has not been made yet;
- Decommissioning of the nuclear plants in about 20 years, proceeding directly to the dismantling stage in order to reach the site release with no radiological constraints.

It is worth mentioning that this announcement brings a new approach for the decommissioning: in fact, also as a consequence of the National Conference on Energy and Environment in the autumn of 1998, the deferred decommissioning strategy (Safe Store) was up to this moment the adopted and agreed strategy by Enel with the Government.

Nevertheless, during 1999 also representatives of APAT (the Safety National Authority) have asked for the possibility of an acceleration, considering "prompt decommissioning" option to be preferred, as well taking into account dose constraints as the need of taking advantage of the reactor operational staff still available on the nuclear sites.

The policy for an immediate dismantling was confirmed with a decree of the Ministry of Industry on 2001, May 7$^{th}$; this decree confirmed also the main objectives outlined in 1999 and stated the opportunity that Sogin would collaborate, under a specific convention, with the Ministry for specific items of Ministerial responsibility concerning siting and construction of the radioactive wastes repository.

Sogin has defined the decommissioning program according to the new guidelines of the government. As mentioned before, the target is to reach the complete radiological release of the site within 20 years from now.

The general programme for all plants has been in principle divided into three phases:

- The first phase will be devoted to all activities that are somewhat independent on the choosen strategy and on the availability of the national repository. Fuel storage and dismantling of BOP, of conventional buildings and lower contamination components are scheduled. In addition, all operating wastes will be conditioned. The general licensing procedure will be executed. This phase should be completed in mid 2005

- The second phase will consider all preparatory activities and mock up realisation for the final dismantling. It will start after the beginning of the realisation of the national repository; we consider that this phase should finish in 2008-2009.
- The third phase will be devoted to the dismantling of nuclear islands, to the transport off all wastes to the repository and to the site restoration. We consider that by the end of 2020 all sites should be released..

Of course, the objectives of this programme can be reached only if the construction of a national repository will be achieved in the due time.

Furthermore, with reference to 2003 year, following items have to be underlined.

After having considered the increase of the risk coming out from the lately international situation, it has been decided to implement new and urgent actions in order to treat radioactive waste present on Italian nuclear sites and to improve safety and security of the nuclear plants, with the centralization of the responsibility and control.

Italian government therefore, with a decree dated February 14th-2003, decided for the "state of emergency" until 31st December 2003, in the areas where nuclear plants exist (Lazio, Campania, Emilia Romagna, Basilicata e Piemonte). Furthermore, with decree dated March 7th 2003, a *Commissioner* deputed for the safety and the security of nuclear plants has been defined. This decision can lead to a simplification of some licensing procedures for decommissioning activities and to a speed up of the selection of the site for the final repository. Due to this new situation, some authorizations for dismantling activities has been quickly released a part from the main decommissioning licence, and an agreement among the main Bodies involved in decommissioning activities has been defined (*Ministry for Productive activities, APAT, Ministry of the Environment*), in order to coordinate and speed-up licensing procedures.

For all plants, during 2003, a special effort was devoted to application for the dismantling and others licensing issue, such as EIA (Environmental Impact Assessment). In addition, many detailed projects were presented to the Safety National Authority, in particular for: the decontamination of primary circuits of Caorso, the decontamination of steam generators of Trino, the removal of asbestos in different buildings of Caorso, Trino and Garigliano, the demolition of cooling towers building in Caorso, evaluation study on graphite removal from Latina reactor, muds and solid wastes treatment and removal from Latina.

Main activities already performed on each plant are hereby summarised.

**Garigliano** (160MW BWR, operated from 1963 to 1978): the global decommissioning plan with the new strategy has been presented to initiate the decommissioning licensing procedure on august, 2001.

The plant was near to reach the safestore condition when the change of strategy occurred. The reactor is defuelled and no fuel is now on the site. The radiological characterisation has been completed. Almost all operating wastes have been treated; no more necessary radwaste tanks have been dismantled and decontaminated. Preliminary works for decommissioning ( site logistic, monitoring facility) are initiated

**Latina** (160 MW GCR, operated since 1962 up to 1987): the global decommissioning plan for initiating the licensing procedure has been presented in Feb. 2002.

The plant has been totally defuelled; the primary circuit has been filled with dry air and blowers and portion of primary circuit outside the reactor building have been dismantled; removal of asbestos from the turbine building and from part of the reactor building has been performed.

**Trino**, (260 MW PWR, operated from 1965 to 1987): the global decommissioning plan with the new strategy has been presented to initiate the decommissioning licensing procedure in Dec. 2001; .the reactor has been defuelled and part of the fuel is now stored in the pool of the plant. An On site Interim storage will be realised by 2003. The removal of asbestos from the turbine building and the demolition of some conventional buildings have been performed. The dismantling of components from the turbine building and the removal of asbestos from the controlled area are initiated.

**Caorso** (850 MW BWR, operated from 1981 to 1986): the reactor has been defuelled and the fuel is now stored in the pool of the plant. On August 4, 2000 the Ministry of Industry issued a Decree authorising specific decommissioning activities (dry storage of irradiated fuel, dismantling of the turbine and Off-Gas, dismantling of the RHR towers, decontamination of the main circuit, treatment of previously produced waste). All these activities are ongoing.
For other activities the global decommissioning plan has been presented on august 3rd, 2001

Recently Sogin carried out a deep re-examination of the NPPs decommissioning costs estimates, also with qualified assistance of international advisors. First assessments indicate a total amount of about 2600 MEURO for the total decommissioning of the 4 NPPs (constant money 2001, including fuel and wastes management and disposal costs). Additional 860 MEURO are estimated as the cost for nuclear fuel cycle plants decommissioning.

As for funding the decommissioning, in the '80, even if there were no precise law disposition in this specific matter, Enel has created a fund for the plants decommissioning and a fund for the irradiated fuel management. A setting aside pluriannual plan has been defined and cumulated funds were transferred to Sogin at the date of its constitution. This amount was adequate to complete decommissioning activities within the Safe Store strategy.

Following the separation of Sogin from Enel, a funding mechanism has been defined to provide resources for additional costs deriving from the different economic conditions (new discount rate and taxes), from the management costs for the new company, and from the change in strategy (from Safe Store to DECON.

A Decree of the Ministry of the Industry issued on 2000, January 26th, states that above mentioned extra costs for Sogin shall be financed on a levy on the price of the sold kWh. Every year Sogin shall present the program of future activities, with associated costs: on this basis, the national Authority for Electric energy and Gas (the National body which defines tariff politics ) shall re-evaluate the levy on kWh due to Sogin for next three years; this re-evaluation will take into account economic efficiency criteria

The same procedure is foreseen by the Decree in order to finance the dismantling of nuclear installations that were property of ENEA and now co-ordinated by Sogin.

### 4.2. Privatisation and deregulation

Nuclear is not an option at the moment in Italy: no impact of Open electricity market in the nuclear sector

### 4.3. Role of the government in the nuclear R& D

In a referendum following the Chernobyl accident, Italy decided to place a moratorium on nuclear power. The moratorium covered both power generation and construction of new nuclear power plants from 1988 to 1992, though the government has since extended the policy. Since the referendum, the Italian government has sharply reduced funding of fission research. While there is some discussion of lifting the moratorium, the Italian environmental movement has only grown stronger in the decade since the referendum, and Italy has shown that it can meet its energy needs

without nuclear power. Most of Italy's current fission research is focused on decommissioning the existing reactors, nuclear safety and disposing of nuclear waste. The rationale for continuing to fund fission research despite the moratorium is that:

- It is important to keep the option of nuclear energy open for the future, particularly given the risk of climate change.
- Italy needs to deal with the nuclear waste problem in any event, if only to decommission the existing nuclear power plants.
- Italy must continue to make progress on several advanced technologies, including accelerators, neutron absorbers and subcritical systems to support the competitiveness of Italian companies in the medium-term.
- The competencies required for fission research are also important to meet the rising demand for nuclear physics technologies in a wide range of applications.

The National Institute of Nuclear Physics (INFN) is the main funding source for all types of nuclear energy research in Italy. Oddly, however, INFN does not mention fission or fusion research in its detailed Five-Year Plans for its research activities and operations. The Applied Nuclear Energy Laboratory (LENA), which receives funding from the INFN and from the University of Pavia, has a small experimental reactor. LENA's research topics include nuclear safety and radiation protection.

ENEA also conducts research on nuclear safety, radioactive waste and nuclear plant engineering, including depressurization systems and reactor containment analysis. Ansaldo Nucleare and several universities are also involved in Italy's fission research.

Most of the Italian government's expenditures on fusion are made in collaboration with Euratom, the European Union's atomic energy agency. ENEA has been assigned the task of coordinating the Italian part of the European fusion program. ENEA operates three facilities under an agreement with Euratom. The main facility is called the Frascati Research Centre near Rome; the other, smaller facilities are in Brasimone and Bologna. The Frascati Research Centre employs about 600 people to study fusion physics and develop engineering and technologies for an eventual European fusion reactor. Frascati has projects to develop materials resistant to radiation and high temperature; to construct superconducting and low-temperature magnets; to develop fusion reactor engineering and to study the irradiation of materials. The Frascati Research Centre houses one of the main Italian-based fusion experiments. The experiment, called the Frascati Tokamak Upgrade, is a pilot study of plasma streams with high-density radio-frequency waves.

Other important Italian fusion research includes:

- The Reverse Pinch Machine (RFX) experiment, which is the largest experiment in the world of its type on magnetic confinement reactor studies; it aims to put three new systems into operation for optimizing high-stream performance
- Studies on plasma theory · Research on inertial confinement ·
- Analyses of new energy from hydrogen and plasma applications ·
- Collaboration on broader European programs including the Joint European Torus (JET).

Because the European Union will make a decision in the next few years about whether to continue its major fusion programs in their current form, the Italian fusion research program is also in a state of uncertainty. If the European Union decides not to extend the Engineering Design Activities for the International Thermonuclear Experimental Reactor (ITER), Italy will need to reshape its fusion program, though there are currently no plans to do away with it, regardless of what happens. http://energytrends.pnl.gov/italy/itref.htm

### 4.4. Nuclear Energy and Climate Change

The Italian electricity market is now fully open to competition. Italy ratified the Kyoto Protocol in June 2002 and launched a national action plan to mitigate climate change in December 2002.

Meeting its climate change mitigation goal is a challenging task for Italy. Despite the target to reduce GHG emissions by 6.5% between 1990 and 2008-12, energy related CO2 emissions have been growing and were already 6.5 % above the 1990 level in 2000. While Italy's carbon intensity, (measured as CO2 emissions per unit of GDP) is relatively low, it can be attributed to high energy prices, low energy intensive industry structure and a mild climate. This advantage may be eroded by lower prices due to market liberalisation and a growing demand for energy in the transport sector. To reduce emissions, the government is considering the possibility to transform the existing carbon tax into a tax on actual emissions. The government also approved the "*Revised guidelines for national policies and measures regarding the reduction of greenhouse gas emissions*" on 19 December 2002, identifying specific policies already decided and exploiting flexible mechanisms as foreseen by the Kyoto protocol. It established a Technical Committee for greenhouse gas Emissions (CTE) to monitor progress and to identify and evaluate additional measures. A number of mitigation measures, either domestic or based on the use of the Kyoto flexible mechanisms, remain to be defined, however, if Italy wants to achieve this goal. It is also a challenge to define the role of coal in the electricity sector, to strike a balance between climate change mitigation and the energy security need for more diversification. More investment in cleaner coal technologies would be necessary. The government's projection to stabilise energy demand in the transport sector between 2005 and 2020 also seems to be over optimistic. The Report recommends that the government should implement the action plan with least cost measures, without delay and with adequate monitoring. Every available policy tool must be mobilised to meet the Kyoto target, including the tax on CO2 emissions and external projects carried out under the flexibility mechanisms of the Kyoto Protocol.

### 4.5. Safety and waste management issues

**WASTES**

At the present time, high-level and low-level waste is stored at production sites (Sogin power plants and ENEA facilities). Vitrification and cementation treatments are under consideration for liquid high-level waste, and cementation for solid high-level waste in category III containers for deep storage.

The quantities of energy related waste currently stored in Italy are about 5500 $m^3$ (almost all of them are $2^{nd}$ category waste) ; the foreseen quantity of waste deriving from dismantling is about 50.000 $m^3$.

**SPENT FUEL**

At the present time, quantities of spent fuel stored in Italy are:

| PROPERTY | NPP | QUANTITIES N. elements | QUANTITIES t HM | CURRENT LOCATION |
|---|---|---|---|---|
| SOGIN | TRINO | 47 | 14,5 | TRINO |
| | TRINO | 49 | 15,1 | FIAT AVIO - SALUGGIA |
| | GARIGLIANO | 259 | 53,3 | FIAT AVIO - SALUGGIA |
| | GARIGLIANO | 63 | 12,9 | FIAT AVIO - SALUGGIA |
| | CAORSO | 1032 | 190,4 | CAORSO |
| | | | | |
| ENEA | ELK RIVER | 64 | 1,7 | CR ENEA TRISAIA |
| | TRINO | 52 | 2,0 | CR ENEA SALUGGIA |
| | GARIGLIANO | 1 | 0,06 | CR ENEA SALUGGIA |
| | VARIOUS | | 0,17 | CR ENEA CASACCIA |
| TOTAL | | | 290,13 | |

At the moment, while all the fuel of Garigliano and Latina plants is away from the reactor (and from the site), spent fuel of Caorso and Trino is still in the reactor pools, whose operation substantially follows the operating procedures valid during the generation period.

In 2003, shipment of spent fuel of Garigliano plant, stored in a pool away from the site, have started in order to send it the reprocessing in UK; already five shipments have been successfully completed for a total of 80 fuel elements (roughly 12 tons).

Sogin is actively carrying on a project for an interim storage facility on the sites of Trino and Caorso NPPs where residual spent fuel of these plants can be kept safely for several decades pending the governmental decision on final disposal. For the temporary on site storage of irradiated fuel, among the various available technologies, the dry storage, inside dual-purpose metallic containers ("cask"), has been chosen.

### 4.6. Other issues

In the framework of international co-operation activities, SOGIN is carrying out consulting and technical assistance activities in the nuclear sector.

A relevant experience in providing consultancy and technical assistance in the nuclear sector, in Eastern Europe and former Soviet Union countries, has been achieved.

In this field SOGIN is presently involved in various projects in the framework of the TACIS Programme, where activities of General On Site Assistance are provided. Major ongoing activities are:

- In Armenia, services provided for the Mezdamor NPP are Project Management, operational safety improvement, including revision and improvement of normal, abnormal and emergency operating procedures, review of Plant Technical Specification, technical assistance in identifying and implementing safety improvements, including general conceptual design development, technical specifications preparation, equipment and services tendering process

management, procurement, assistance to licensing, installation, testing and commissioning supervision, .

- In Kazakstan, services provided for the Aktau NPP are Project Management, technical assistance in identifying and implementing safety improvements including technical specifications preparation, equipment and services tendering process management, procurement, installation, testing and commissioning supervision technical assistance in decommissioning planning, in safe enclosure preparation, decommissioning cost evaluation.
- In Russian Federation, services provided for the Beloyarsk NPP are conceptual design of improvements, technical specification and tender documentation preparation, support to licensing and procurement, supervision on installation and commissioning. Services provided for Bilibino NPP are Project Management, technical assistance in identifying and implementing safety improvements, including general conceptual design development, technical specifications preparation, equipment tendering process management, procurement, assistance to licensing, installation, testing and commissioning supervision.

In the specific field of decommissioning and waste management, Sogin has a specific know how on sludge wastes retrieval and conditioning. The technology has been successfully tested in Garigliano Plant and is now being demonstrated in Hunterstone NPP (UK, BNFL). A consultancy activity is ongoing for the decommissioning of nuclear installations of JRC Ispra.

## REFERENCES


[1] Il regime giuridico dell'impiego pacifico dell'energia nucleare, Vol. I, II and III, ENEA, Roma, (1986) (Volumes II and III present the whole set of international agreements in which Italy participates).

[2] Il Nucleare in Italia, special edition of Professione Ingegnere, Anno 5, N.19/20, Luglio-Dicembre, (1992).

[3] Energia, ambiente, innovazione dal CNRN all'ENEA, a cura di G. Paoloni, Laterza; Bari, (1992).

[4] La questione energetica: dieci anni perduti 1963-1973, F. Ippolito, F. Simen, Feltrinelli; Milano, (1974).

[5] Il ruolo dell'organizzazione industriale nello sviluppo nucleare, P. Berra, A. Ninni, S. Vaccà, Economia delle fonti di energia, XXXIII, N. 42, (1990).

[6] Data & Statistics, The World Bank, www.worldbank.org/data.

[7] IAEA Energy and Economic Data Base (EEDB).

[8] IAEA Power Reactor Information System (PRIS).

[9] IEA, Beyond 20/20.

## Appendix 1

## INTERNATIONAL, MULTILATERAL AND BILATERAL AGREEMENTS

*AGREEMENTS WITH THE IAEA*

| | | |
|---|---|---|
| • Amendments to Articles VI & XIV of the Agency statute | Not ratified | |
| • Agreement on privileges and immunities | Entry into force: | 20 June 1985 |
| • NPT related agreement INFCIRC/193 | Entry into force: | 21 February 1977 |
| • Additional Protocol (GOV/1998/28) | Signature: | 22 September 1998 |
| • Supplementary agreement on provision of technical assistance by the IAEA | Not Applicable | |
| • EURATOM | Member | |

*MAIN INTERNATIONAL TREATIES etc.*

| | | |
|---|---|---|
| • NPT | Entry into force: | 2 May 1975 |
| • Convention on physical protection of nuclear material | Entry into force: | 6 October 1991 |
| • Convention on early notification of a nuclear accident | Entry into force: | 11 March 1990 |
| • Convention on assistance in the case of a nuclear accident or radiological emergency | Entry into force: | 25 November 1990 |
| • Vienna convention on civil liability for nuclear damage | Not applicable | |
| • Paris convention on third party liability in the field of nuclear energy | Entry into force: | 17 September 1975 |
| • Joint protocol relating to the application of Vienna and Paris conventions | Entry into force: | 27 April 1992 |
| • Protocol to amend the Vienna convention on civil liability for nuclear damage | Signature: | 26 January 1998 |
| • Convention on supplementary compensation for nuclear damage | Not signed | |
| • Convention on nuclear safety | Entry into force: | 14 July 1998 |

| | | |
|---|---|---|
| • Joint convention on the safety of spent fuel management and on the safety of radioactive waste management | Signature | 26 January 1998 |

*OTHER RELEVANT INTERNATIONAL TREATIES AND UNDERTAKINGS*

| | | |
|---|---|---|
| • Improved procedures for designation of safeguards inspectors | Rejected but agreed to special procedures | |
| • ZANGGER Committee | Member | |
| • Nuclear Export Guidelines | Adopted | |
| • Acceptance of NUSS Codes | Summary: National regulations are in conformity with revised codes. Codes are sound international safety standards which should be made obligatory in all states operating NPPs. Letter: | 27 December 1989 |
| • Nuclear Suppliers Group | Member | |
| • Establishment of CERN with 12 other European Countries | Paris | July 1953 |
| • Halden Boiling Water Reactor project Italian representative: ENEA | | June 1958 |
| • Joint European Torus Undertaking Italian representatives: ENEA and | Brussels CNR | May 1978 |

## Appendix 2

## DIRECTORY OF THE MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

*NATIONAL ATOMIC ENERGY AUTHORITY*

Ministry for Productive Activities
(MAP)
Via Vittorio Veneto, 33
I-00187 Rome, Italy

Tel: +39 6 470 51
Fax: +39 6 470 528 44
Telex: 616315 MICA

Italian Agency for New Technology,
Energy and the Environment (ENEA)
Lungotevere Thaon di Revel, 76
I-00196 Rome
Italy

Tel: +39 6 3627 1
Fax: +39 6 3627 2591/2214
Telex: 610183 ENEA
http://www.enea.it/

*NATIONAL REGULATORY BODY*

Italian Agency for Environmental
Protection (APAT)
Via Vitaliano Brancati, 48
I-00144 Rome, Italy

Tel: +39 6 500 71
Fax: +39 6 500 729 16/722 19
http://www.sinanet.APAT.it/

*NUCLEAR INDUSTRY*

**Supply of Nuclear Power Plants**

ANSALDO S.p.A. Nuclear Division
Via Corso Perrone 25
16161 Genova.

Tel: +39 10 6551

**Operation of Nuclear Power Plants**

SO.G.I.N p.a.
Via Torino 6
00184 Roma

Tel: +39 06 85091

**Fuel Fabrication**

FN S.p.A. Nuove Tecnologie e Servizi Avanzati
S.S. 35 bis dei Giovi Km 15
15062 Bosco Marengo - Alessandria

Tel: +39 131 2971
Fax: +39 131 297250

**Transport**

| | | |
|---|---|---|
| Air carrier: | Alitalia<br>Via della Magliana 806<br>Roma | <br>Tel: +39 6 65629133<br>http://www.alitalia.it |
| Land Carriers: | | |
| | MIT Nucleare<br>Via dell'Artigianato 12<br>Carugate (Mi) | <br>Tel: +39 2 921591<br>Fax +39 2 92150244 |
| Rail Carrier: | Ferrovie dello Stato<br>Piazza della Croce Rossa 1<br>Roma | <br><br>Tel: +39 6 47305700 |
| Marine Carrier: | Lloyd Triestino S.p.A.<br>Piazza Unità d'Italia 1<br>Trieste | <br><br>Tel: +39 40 3180111 |

Several other carriers are licensed for radioactive and fissile materials, their addresses are available from APAT or from the Ministry of Industry.

**Waste Management** NUCLECO
Via Anguillarese 301
Roma

*NUCLEAR RESEARCH INSTITUTES*

ENEA/CRE
Via Anguillarese 301
S.M. di Galeria (RM)
Tel: +39 6 30481
Fax +39 6 30494203
http://www.casaccia.enea.it/

CNR
le A. Moro 7
Roma
Tel: +39 6 49931
Fax +39 6 4461954
http://www.cnr.it/

National Institute for Research
in Nuclear and Subnuclear Physics (INFN)
Piazza dei Caprettari 70
Roma
Fax: +39 6 68307924
http://www.infn.it/

Abdus Salam International Centre
for Theoretical Physics (ICTP)
http://www.ictp.trieste.it/

European Centre for Theoretical Studies
in Nuclear Physics and Related Areas (ECT)
http://www.ect.it/

*HIGH ENERGY INSTITUTES*

Elettra Synchrotron Light Source
http://www.elettra.trieste.it/

Frascati National Laboratory (LNF)
http://www.lnf.infn.it/

ENEA (Frascati, Italy)
http://www.frascati.enea.it/FTU/

*OTHER ORGANIZATIONS*

| | |
|---|---|
| Ministry for University based Science and Technology | http://www.miur.it/ |
| International Centre for Genetic Engineering and Biotechnology (ICGEB) | http://www.icgeb.trieste.it/ |
| International School for Advanced Studies (SISSA) | http://www.sissa.it/ |
| Department of Electrical and Automation Research | http://www.pea.enel.it/ |
| The Journal of High Energy Physics (JHEP) | http://jhep.sissa.it/ |
| Architecture and Engineering Virtual Library | http://www.uniroma1.it/cobai/bibvirt/start.htm |