NUCLEAR ENERGY IN ITALY

By

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Abstract

1969 was the final year of CNEN's - Italian Committee for Nuclear Energy - second Five-year Plan, in the course of which, the foundations were laid for the lines of nuclear development in the next decade, and even beyond it.

CNEN's principal programmes are the following:

- CIRENE heavy water reactor programme within which a 35 MWe pressure tube heavy water moderated reactor prototype is under construction at Latina. The reactor will use natural or slightly enriched uranium and cooled by light water in a two-phase water/steam mixture;
- the Fast Reactors Programme is finalized in the construction of PEC a fuel element testing reactor with a 116 MWt rated power and 140 MWt maximum power;
- as the result of the collaboration between CNEN and the Italian Navy will be constructed the "Enrico Fermi" a logistic support ship of 18,000 t, powered by an 80 MWt PWR;
- other CNEN reactor programme concerns ROVI organic moderated reactors for desalination with a capacity of fresh water per day from 50.000 to 200.000 $m.^3$;
- as to fuel reprocessing activities two pilot plants are in operation, namely EUREX at Saluggia and ITREC at Trisaia;
- EUREX 2 a full size industrial reprocessing plant, will be constructed in the near future - jointly by CNEN and Italian industry;
- CNEN's activities refer also to research and development work for uranium enrichment plants, to fuel fabrication, to plutonium fuel development, to biology, to agriculture, to geomineralogy and high energy nuclear physics.

ENEL - the Italian National Electricity Board - has recently awarded the contract for the fourth Italian Nuclear Plant, a 783 MWe BWR. The other Italian power plants in operation are namely the Latina 200 MWe GCR, the Garigliano 150 MWe BWR and the Trino Vercellese 247 MWe PWR.

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Italy is present in a well-defined position in the great contest which will soon lead nuclear energy to absorb the largest portion of new

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investment in the field of power generation.

2. This position is that of an industry which on the one hand is operating in a system in which social problems and the general interest must find the proper balance with the specific interest of the production sector, and on the other is faced with the necessity of reaching the new technological positions of nuclear specialization in conformity with the standards of market which is becoming increasingly internationalized through a steady disappearance of the barriers of economic protectionism.

3. The first of these two conditions demands that the industry quickly achieve a mastery of the design and construction problems involved in the various types of facilities making up the cycle of peaceful use of the atom, so that it can meet the demand which national planners are preparing to address to the industry, with a view to coping with a national energy requirement now increasing at an annual rate in excess of nine per cent. I shall just briefly mention that from this viewpoint a major role is played by the general economic planning process conducted through the work of the Italian Economic Planning Committee, CIPE. This technical-political body lays down in general the objectives and means to achieve them and, as far as the nuclear sector is concerned, it tends, with the due allowance for the skills and knowledge acquired in the last few years by public and private industry, to orient the technical guidelines towards the objectives of the national power programme.

4. In connection with the second of the two conditions, instead, it should be noted that industry, in perfecting its specialization in the nuclear field and in planning its investments, is operating under conditions of free competitions with foreign nuclear industries and in a market which will only gradually achieve sufficient dimensions to permit the co-existence of several enterprises in the individual phases of nuclear production. In the short-term range, therefore, the problem of industrial efficiency demands the concentration and coordination of industrial efforts and capabilities.

5. This, in its essential lines, is the political-economic framework in which CNEN - the Italian Committee for Nuclear Energy- as the

State's research arm, is called upon to perform its tasks. The latter belong in a sphere of action which differs materially from that of the atomic Commissions or Authorities of many other countries that have achieved a high degree of nuclear development, since CNEN does not actively intervene in the area of the production and marketing of industrial products, does not act as an industrial architect, nor does it rigidly lay down technical guidelines which industry must necessarily follow on pain of being excluded from the industrial sector, but rather strives to promote industry's interest and active participation in its own research and development programmes even before to reach the level of industrial exploitation, so as to maximise the chances that the development lines followed in the stage of research and experimentation will then yield concrete economic and industrial results.

6. The end of 1969 coincides with the terminal phase of CNEN's second five-year plan, in the course of which the foundations were laid for the lines of nuclear development in the next decade and even beyond it. In this five-year period, which started in 1965 and provided for the spending of about 250 millions dollars, not only has major progress been made in the development of pilot plants and in the designing of prototypes, but there was also consolidated, in parallel with CNEN's programme, the industrial organization and the fabric of inter-industry arrangements which will permit a rational development of the productive sector connected with the exploitation of the atom.

7. To make my discussion easier I shall divide CNEN's programme into activities concerning reactors and projects pertaining to fuels.

8. As regards reactors I shall mention first of all the CIRENE project which CNEN is carrying out in cooperation with the National Electric Power Agency- ENEL - and for which the Ansaldo Meccanico Nucleare Company has been entrusted with the role of 'industrial participant'. Within the framework of this project a 35 MWe pressure tube heavy-water moderated reactor prototype is being constructed at Latina, in the area of the existing 200 MWe GCR. The reactor will use natural or slightly enriched uranium and cooled by a light water "fog".

9. In any case, enrichment will have to be so low as to exclude the economic advisability of reprocessing the spent fuel. A possible

change in the project envisages the operation of the reactor on the U - 238-Pu cycle. This solution would enable to re-use the Pu formed in the reactor during operation. A third change on the fuel cycle is the one contemplating the use of thorium. By adding the latter to the nuclear fuel it would be possible to obtain a production of new fissionable material in the form of U-233 which would enable a high conversion factor.

10. The CIRENE prototype - entirely conceived in Italy - will constitute for CNEN a test bench for the research and development conducted in the last few years on reactors in this new line and, for industry, a design and construction experience which can be extrapolated to industrial - scale plants.

11. Another, longer-term programme concerns fast reactors, the aims being not only to obtain for the country, beginning in the early eighties, a more economical source of energy, but also to solve the problems of the utilization of the plutonium produced in Italy's water reactors. In its present stage the programme is finalized in the construction of PEC (Fuel Element Testing Reactor) and of a Test plant for sodium cooling circuits and in particular for intermediate heat exchangers and steam generators.

12. The PEC reactor will be built by 1974 - on the CNEN site "Brasimone" near Bologna - by SNAM PROGETTI (ENI Group) which has established an "ad hoc" consortium with Societa Italiana Impianti (IRI Group). The fixed - price contract is worth about 40 million dollars.

13. This reactor, with a 116 MWt rated power and a 140 MWt maximum power, will be used for the development of fast reactor fuel and the performance of instrumented experiments on whole fuel elements.

14. The conceptual design of the reactor, worked out by CNEN Fast Reactor Program, will be brought to final stage by CNEN and industry designers.

15. The basic reactor characteristics are the following. The core is divided into two zones i.e. a testing zone and a driver zone. Primary sodium will have an inlet temperature of 370°C and an outlet temperature of 525°C. Sodium will be used also for the secondary circuit and heat will be dispersed in the air.

16. The experimental space will include three test channels with a volume of about 100 litres each within a separate cooling circuit. The inside diameter of each channel is about 100 mm, with a useful height of about 900 mm. The primary sodium of the three independent circuits, will have an inlet temperature of 450°C and an outlet temperature of 600°C. The structures of the three channels can be readily converted, so as to be united and form a single channel. The central core zone includes three more positions, where instrumented experimental elements cooled by the main circuit can be loaded.

17. The reactor will enable experiments to be conducted under stationary and transient conditions, and the experimental melt-down of some rods in the testing zone may be obtained, while operation with vented-type elements will also be possible.

18. The primary task of PEC will be the development of a fuel element for power reactors with a very high average burn-up rate, of the order of 100,000 MWd/t. The vented-type element, with the discharge of fission products into the coolant, will be stainless steel - clad.

19. In the course of this second Five-Year Plan, important work was also done in the field of reactors of ship propulsion, as a result of the activities of a Committee of Experts formed with the sponsorship of CNEN and composed of representatives of the various industrial sectors and governement agencies concerned. An agreement between CNEN and the Italian Navy has then resulted in the overcoming of the last obstacles to the launching of a programme for the building of a Naval logistic-support ship, powered by a pressurized-water reactor.

20. The FIAT has forwarded an offer for the nuclear power system and it is considered that definition of the industrial agreement will be reached very soon. 90% of the nuclear plant components, including all the internal reactor parts, will be built by the national industry. CNEN will obviously have responsibility for the more strictly nuclear aspects of the project, including the critical experiment which will be completed in the next days at the CNEN Casaccia Center, while the Italian Navy will handle the building of the vessel.

21. The Enrico Fermi, logistic support ship, will have an 18,000 t

displacement, and the power plant, with an 80 MWt PWR, will have a 22,000 SHP power and a maximum speed of 20 knots. With the definition of industrial contracts, times may be speeded up and it is considered that the ship will be at sea by 1972/3. The overall project cost is estimated at about 35 million dollars.

22. When interest turned away from organic-moderated reactors for power generation purposes in large plants, a study was made by CNEN with attractive prospects, of the possibility of utilising the organic concept in small and medium plants for the generation of industrial steam, which is of special interest to many developing countries in connection with its possible application in water desalting plants. CNEN thus promoted the formation of a consortium of Italian Industries which took note of the favourable prospects of the ROVI process steam organic reactor for desalination, and decided to start work on the commercial promotion of the enterprise.

23. The now completed design has confirmed that ROVI-type reactors, with thermal power ranging from 100 to 400 MW, are particularly suited to the production of low-temperature steam for the operation of desalination plants capable of producing from 50,000 to 200,000 cu m/d of fresh water.

24. The advantages of this type of plants include that of being exclusively designed for desalination without being tied to the simultaneous production of electric power so as to obtain economical costs. Hence this original Italian contribution has met interest in many developing countries, especially in the Mediterranean area.

25. This first phase of the project provides for the building of a prototype reactor in an Italian area.

26. Another advantage of the ROVI project is that the materials and technology to be adopted make it possible for the whole reactor to be built in Italy by the seven member companies of the Consortium: Breda, Fiat, Montecatini-Edison, Snam Progetti, Snia Viscosa - BPD, Societa Italiana Impianti, and Sorin.

27. The second major chapter of CNEN's activities is concerned with fuel. In the last few years there has been built up in Italy, through

the activities of CNEN supplemented by those of industry, a satisfactory body of know-how on the problems of fabricating metal rod fuels for gas reactors and ceramic rod elements for water reactors. We are now capable of fabricating under license fuels for tested reactors and of introducing in the processes purchased above new and original modifications, such as the sol-gel process, deriving from national research.

28. The second goal to be achieved, towards which the present programmes are turned, is that of the acquisition of a fuel design know-how, providing a national alternative to the purchasing of foreign licenses and leading at a later stage to an industrial fuel policy based on a rational concentration of production activities.

29. This line of development of an independent know-how is exemplified with particular evidence by CNEN's Plutonium Program, the main objective of which is to acquire in the shortest possible time the knowledge required for the development of plutonium-based ceramic fuel, solving among other things the difficult problems involved in handling a highly toxic material. The special equipment for this line of experiments was built by Sorin, a joint venture of Fiat and Montecatini-Edison and installed in CNEN's Plutonium Laboratory at Casaccia Center which is fully operating since 1969.

30. If then from the stage of production we move on to that of the reprocessing of irradiated fuel we can state that the Italian industry, through its participation in CNEN's programmes, has achieved a considerable degree of progress. Two pilot plants, Eurex and Itrec built by national industry, are about to go into operation in CNEN Centers. They are now both undergoing the cold runs.

31. The EUREX pilot plant has been designed and optimised for the reprocessing of highly-enriched MTR-type uranium fuel element. At the same time it is sufficiently flexible to permit a plant-scale research on the reprocessing of fuel elements of natural uranium or uranium enriched up to 5%, clad with aluminium, magnesium, zirconium or stainless steel. The EUREX plant will be capable of reprocessing 25 to 30 tons a year of uranium enriched up to 5%.

32. The purpose of the plant is to test, on a scale to which the

results can be extrapolated to larger plants, both new chemical extraction processes and the resistance and adequacy of the equipment and control instrumentation. This is with respect to both highly enriched uranium fuels natural or slightly enriched uranium like those now used in Italy's three nuclear power stations.

33. The ITREC plant of CNEN was inaugurated in 1968 at the Trisaia nuclear research centre in the South of Italy. The Trisaia Plant for the reprocessing and re-fabrication of fuel elements will handle, for about two and a half years, the reprocessing of the spent Th-U-235 oxide fuel making up the first core of the BWR at Elk River, Minnesota, U.S.A., the plant may be then utilized for the reprocessing of U-Th fuels of such advanced reactors, while a subsequent and important utilization will be reprocessing of fast reactor Pu fuels.

34. Furthermore, the construction of an industrial plant which is to meet the demand for fuel reprocessing in Italy in the late seventies has been planned.

35. The plant should be realized by a company to be formed by ENI (about 70% of the capital) by IRI Group (about 10% capital) and by private industry (about 20% capital). The initial capacity of the plant should be of about 500 tons/year.

36. Also CNEN will be associated to the undertaking in view of the extensive knowledge acquired by the Committee in the field of reprocessing.

37. In view of the realization of this project, in April 1969 CNEN and Snam Progetti have concluded an agreement for the designing of the plant, which has been named EUREX-2.

38. Among the programmes that will result in the near future in technological developments must be mentioned, because of their importance, the activities promoted by CNEN in relation to the uranium enrichment problem. This matter is now in the limelight of European attention, and Italy sincerely hopes that the decision will be made to proceed with the construction of an European enrichment plant, using the technique that will be judged most appropriate in relation to the size of the European requirements.

39. CNEN acted in this field to stimulate the interest of the most advanced Italian industries, establishing the Italian Uranium Enrichment Group (GIAU), the industrial participants in which include Efim-Breda, Fiat, Iri-Finmeccanica, Montecatini-Edison, Snia-Viscosa and Snam Progetti. The purpose of this project is to conduct a technical feasibility study and distribute among the various industries, in relation to their specialized skills, the various design and construction aspects of an enrichment plant. The programme is underway and the first results have been proved to be satisfactory.

40. The CNEN's principal effort has been concentrated mainly on applied research; at the same time intensive effort has been devoted to fundamental research, the main part of which regards high energy nuclear physics. The most important facility in this field is Adone, the 1.5 GeV electron and positron intersecting storage ring, designed and constructed at CNEN National Laboratories at Frascati.

41. Other important research has been conducted into biology, agriculture and geo-mineralogy.

42. Biological research has dealt mainly with radiation interaction in man as a means of protecting human beings and, more particularly, of repairing damage caused by radiation.

43. As far as agriculture is concerned research has been principally directed towards using radiation to improve plant genetics and to protect agricultural produce.

44. The presence of ENEL (the Italian National Electricity Board) in the nuclear sector is proved by the operation of three power plants: the Latina 200 MWe GCR, the Garigaliano 150 MWe BWR and the Trino Vercellese 247 MWe PWR.

45. Few weeks ago ENEL ordered the fourth Italian nuclear plant, awarding the contract to the Ansaldo Meccanico Nucleare Company (of the IRI- Finmeccanica Group) which submitted the bid jointly with General Electric Company. The Nuclear station will be equipped with a 783 MWe BWR and will be located at Mezzanone near Piacenza in the North of Italy. The total cost of the project at the moment of first plant operation (inclusive of all indirect costs) will be about 224 million dollars.

Italian industry will supply about 80% of the value of the station, to be operational in 1975.

46. This order is the first step - now that nuclear energy has become competitive - of ENEL's second stage nuclear station construction programme. This programme includes, as ENEL has announced, the order of the fifth nuclear plant to be awarded in the immediate future.

47. In the year which followed the construction of the first three plants, the Italian nuclear industry has continued to work both in the national and in the international markets with courage and confidence. While some re-organizational moves have taken place, new companies have entered the field.

48. About 40 firms have full capability in manufacturing equipment for nuclear installations (both power stations and fuel - fabrication or reprocessing - facilities). Of them, six companies qualify as "general contractors" for the construction of complete plants, acting also as "chef de file" of consortia or groups and with possible connections with international manufacturers. Three of these are public concerns: Snam Progetti of Sandonato Milanese, as company in the field for the ENI State Group; Ansaldo Meccanico Nucleare of Genao, as the leading company for the IRI-Finmeccanica State Group and Breda-Termomeccanica & Locomotive of Milan as leading company for the EFIM State Group. The other three are private concerns: FIAT of Turin whose activities in the nuclear field include also the construction of the reactor for the Italian nuclear ship Enrico Fermi; Montecatini Edison, which has concentrated the experience of Edison in the construction of the Trino Vercellese plant, and the activities undertaken by the nuclear section of Montecatini; and SNIA Viscosa of Bombrini Parodi-Delfino, the chemical company active in the construction for CNEN of the fuel plants EUREX and PCUT.

49. From the review of the activities carried out in Italy the conclusion can be drawn that nuclear energy is becoming one of the essential factors that determine the economic growth and the progress of this country.