



Fourth regular session

Item 12 of the provisional agenda
(GC(IV)/109)

THE DEVELOPMENT OF NUCLEAR POWER

Activities to stimulate the development of nuclear power

Report of the Board of Governors

I. INTRODUCTION

1. The General Conference, at its third regular session, examined the report of the Board of Governors on assistance to less-developed countries with the production of nuclear power, [1] gave new directives supplementing those already embodied in an earlier resolution [2] and requested a report from the Board at its fourth regular session on the progress achieved and on the Agency's future programme. [3]
2. The General Conference further requested the Board to submit a general report on the economics of nuclear power. [4] That subject is dealt with in a separate document. [5]
3. The steps taken to implement resolutions GC(II)/RES/27 and GC(III)/RES/57 fall under the following two headings:
 - (a) The Agency makes available its services to individual Member States at their request, in order to provide them with the assistance they may need for their future plans of nuclear power development, and, in particular, it helps them to carry out studies of the technical as well as the economic aspects of their power programmes; and
 - (b) The Agency undertakes general studies on the economics of nuclear power, which include the continuing collection and analysis of available data on nuclear power costs, in order to assist Member States in making comparisons and forecasts of nuclear power costs which would apply to their specific situations.
4. Thus the Agency endeavours to secure and make available to Members the latest technical and cost data on nuclear power plants, and to devise methods for their interpretation and extrapolation. At the same time it stands ready to assist any State which might consider the introduction of nuclear power within a well-defined context.

[1] GC(III)/76.

[2] GC(II)/RES/27.

[3] GC(III)/RES/57, paragraph 4.

[4] Ibid., paragraph 5.

[5] GC(IV)/123.

5. The Agency, with its limited resources, cannot take all the intermediate steps between the analysis of data and the specific application of nuclear power to a given situation. It appears that unless a fairly advanced study of the future power development of a country has first been carried out it would be difficult to expect fruitful results from an enquiry into the introduction of nuclear power.

6. It is from objective studies of specific cases where enough preparatory work has been done that the Agency hopes to secure the greatest benefits, not only for the Member State concerned but also for other Members for whom many of the results may prove of relevance and serve as a useful guide.

II. STATUS OF NUCLEAR POWER IN MEMBER STATES

7. Nuclear power is still in the developmental stage and constant improvements are being made, both in its technology and economics. The costly investments needed for the first generation of power reactors have as yet only been undertaken by the most industrialized countries. Thus only France, the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland and the United States of America are at present actually operating nuclear power plants, while other industrialized countries like Canada, Czechoslovakia, Italy and Japan are actively engaged in building power reactors. Among Member States outside Europe and North America, only Brazil and India have announced definite plans for installing nuclear power plants. These countries too have achieved industrial development in specific areas, despite the fact that because of their large size and population, the general level of economic development as expressed, for example, in per capita income is still well behind that in the more industrialized countries.

8. The fact that there is a close link between a high degree of industrialization and the possibility of an early introduction of nuclear power is not solely due to the level of technical knowledge or the financial resources available in the more developed countries. It is also rooted in the present technical and economic characteristics of the construction and operation of nuclear power plants. In the last analysis and after due allowance has been made for a transitional period when higher costs may be incurred for later gains, the introduction of nuclear power must be justified by the expectation of achieving a saving in the cost of the energy produced or at least a saving in the foreign exchange component of this cost. In comparing the relative economic merits of nuclear and conventional power several factors should be borne in mind; for instance, in the case of nuclear plants, the investment cost per unit capacity is higher and increases rapidly as the plant size decreases. On account of this high capital investment nuclear plants have to be operated at high load factors. Further, in order to achieve the maximum saving of foreign exchange through the introduction of nuclear energy, special industries for fabricating components will have to exist within the country where the reactor is operated. These considerations underline the importance of having an interconnected power system with a sufficient base load to accommodate a large reactor, as well as a broad industrial base to start some entirely new industries designed to support a general programme of atomic energy embracing several generations of power plants.

9. In contrast to this, the less-developed areas are characterized by a limited and undiversified industrial infrastructure, low consumption of energy produced by isolated power units, and often by the presence of large conventional energy resources, especially hydro, which may not have been fully explored or evaluated. This may account for the fact that various international financing organizations show more hesitation at the present time to support projects for nuclear power than for conventional hydro or thermal plants. However, it is reasonable to assume that as costs decline and technical operating experience accumulates, the favourable prospects which nuclear power could have in certain cases in comparison with conventional alternatives will be more widely recognized.

10. The possibility of utilizing small nuclear power stations in remote areas has often been mentioned as an attractive prospect, although the competitive conditions facing the installation and operation of a reactor in such a location would be severe. In addition, there is at present little satisfactory information on the costs of small reactors.

Consequently, the Agency has concentrated its first efforts on securing a maximum of up-to-date technical and cost data for these plants. No situation where a prima facie case had been made for the possible use of a small reactor rather than a conventional power source has as yet been brought to the attention of the Agency in response to its initial enquiries, although continued attention is being devoted to this matter.

11. However, the foregoing should not be taken as implying that there is no case at all for nuclear power generation in the so-called less-developed countries. First, as mentioned earlier, there are in these countries areas with the necessary degree of industrialization. Secondly, there are less-developed countries with areas which have a large industrial potential based on adequate supplies of raw materials, where the inhabitants possess many of the necessary industrial skills, either actual or potential, and which are located within easy reach of a comparatively large market. Even in such favourable situations, progress in industrialization may be hampered by an inadequate power supply resulting from the shortage of conventional fuel, the heavy transportation costs involved in moving such fuel to the area, and/or the excessive foreign exchange burden of imported fuel. In such circumstances, there could well be a case for nuclear power generation - even at a cost which is initially higher than that of power generated by conventional means - if there is a clear indication that, in the foreseeable future, industrial development would create a substantial base load to make nuclear power economical.

12. When such concrete cases come to light, as a result for example of the surveys referred to in section III below, the Agency would consider the best means to facilitate introduction of nuclear power in the area, perhaps through the installation of a small or medium sized reactor as a demonstration project, with a view to making its benefits available to the largest number of Members.

13. The above is a brief description of the present transitional period. Operating experience and new cost data which will become available in the next two or three years from the first generations of nuclear power plants now in operation or under construction in only a few of the most industrialized countries will provide firmer figures of generating cost on the basis of which the competitive status of nuclear power will be more fully assessed.

III. ASSISTANCE TO MEMBER STATES IN CONNEXION WITH THE DEVELOPMENT OF NUCLEAR POWER

14. The Agency's role in connexion with the development of nuclear power must necessarily be different with respect to areas or countries in differing stages of industrialization. In industrialized areas the Agency will endeavour to stimulate as complete an exchange of technical and economic information as possible. It is felt that such exchanges of views among advanced countries that have followed different lines of thought, will be a good method of detecting the "soft spots" on which attention should be concentrated in order to reduce the cost of nuclear power.

15. Referring also to industrialized areas such as those referred to in paragraph 11 above, the Agency will always be prepared to provide help and advice in regard to any nuclear power project contemplated. Mention may be made here of the project to build a 150-200 MWe nuclear power station in the Rio de Janeiro-Sao Paulo areas (the Mambucaba Project), for which Brazil has already requested the Agency to provide experts on third party liability and nuclear safety. In the future the Agency may be called upon to play a more active role for projects of this nature, for instance in the preparation of an invitation for international tenders.

16. In the case of countries which have not yet reached any decision regarding the installation of their first nuclear power plant but which have already a large amount of experience in industrialization and conventional energy production and distribution, the Agency's assistance might be concerned with analysis of the conditions under which a first nuclear power plant could be profitably installed within an existing power network.

Evaluations of this type require the power system in the area concerned to be already well developed, and extrapolation of its expansion during, for example, the next ten years to be based on long experience in the past.

17. The case of Finland provides a good example in point. On 3 December 1959 Finland invited the Agency to participate in joint studies with a view to determining the possible role of nuclear power in the country within the next decade.

18. The Finnish Atomic Energy Commission, in co-operation with the largest electricity supply undertaking, the state-owned Imatran Voima Cy, has set up a study group headed by the Chairman of the Commission. Following approval by the Board, the Director General designated a member of the Secretariat to serve as the Agency representative and as a special assistant to the head of the study group. An agreement between the Agency and the Commission providing for co-operation in carrying out these studies was signed on 3 March 1960 and the work was started later that month. The first phase of the studies consisted in a survey of the power resources of the country and the analysis of estimated future power demands. The bulk of this work, primarily concerning conventional power, was carried out by the Finnish study group, but the Agency co-operated by indicating and analysing data of particular importance in assessing the future role of nuclear power. One of these important factors - in a country where the power system is predominantly hydro-electric and thermal power is used to support hydro-electric power in times of high demand or low water - is the evolution of thermal production from peak to base-load duty. Finland has already developed approximately one half of its economic hydro-electric potential and the transition of a part of the thermal capacity to base-load duty will become an important feature of the power system in the next decade. The possible role of nuclear power in providing for that part of the thermal base-load can only be assessed after an economic analysis of power generating costs in alternative types of prime movers. It is expected that this phase of the studies will be completed by the end of July 1960, and that the report dealing with this question will be available to the Agency shortly thereafter.

19. In lesser developed countries, in the commonly accepted sense of the term, such accurate forecasts of power programmes may not be possible. It must be stressed that any serious plans for introducing nuclear power into a system can only be based on the knowledge of the availability and cost of power from conventional sources as well as of the estimated future power needs. Consequently the investigation to be carried out by the Agency of the possible role of nuclear power in these countries will have to be based on such preliminary power studies.

20. One example of this type of situation is that of the Philippines which has requested the Agency's assistance, under the programme to implement resolutions GC(II)/RES/27 and GC(III)/RES/57, in initiating a study in the latter part of 1960 of the potential role of nuclear power in the Philippines over the next decade.

21. The study in its first stage would be mainly concerned with the economic and technical aspects of the possible installation of a nuclear power plant in the Manila area of the Luzon integrated network during the next decade, particularly keeping in view the power demand in the area and, more generally the economic and industrial factors of the whole country. In addition, it might be possible to initiate a subsequent enquiry into the economic and technical conditions under which nuclear power could contribute to the development of an isolated region's natural resources in one of the numerous Philippine islands.

22. Two specialists will be sent to the Philippines by the end of the year for the purpose of initiating this study. It is contemplated that the Philippine authorities will provide such other specialists as may be required.

23. Preliminary indications have also been received of the possible interest of other Member States in surveys of the same nature.

24. More important than the provision of assistance to individual Member States at their request is the fact that the nuclear power studies referred to above may serve as a useful guide to other Members. These concrete studies will show the problems which a country may have to face at a given stage of industrialization when contemplating installation of nuclear power in the years to come, and will give a clearer view to power reactor manufacturers of the conditions under which they may expect to take part in the installation of nuclear power plants abroad.

25. It is therefore considered useful for the Agency to continue to carry out a limited number of similar pilot studies in the forthcoming year arising out of specific requests from Member States. In this connexion, it would seem desirable that future pilot studies should relate to situations as diversified as possible and should be concerned with problems such as the stage of industrialization, local conventional power resources, climatic conditions, and financing possibilities, and that they should lead to useful general conclusions. It would also appear appropriate that consideration should be given to cases where nuclear energy may be considered for purposes other than the mere production of electricity, such as industrial process heat and water desalting. Member States of the Agency will thus have at their disposal a set of nuclear power evaluations from which they can extrapolate when planning their own nuclear power programmes.

26. Whenever appropriate, the United Nations will be invited to participate in these activities.

27. As indicated in last year's progress report, the Agency, when carrying out studies in connexion with the nuclear power programmes of its Member States, will endeavour to meet their related needs for technical assistance and training; at the same time it is clearly desirable for Member States to ensure that their training requests are properly timed in relation to their nuclear power programmes.[6] In connexion with training programmes, the Secretariat is carrying out preliminary investigations to find out whether it would be possible, in specific instances, to send selected trainees to participate in the programme of development of small and medium power reactors initiated by the United States Atomic Energy Commission (USAEC).

IV. TECHNICAL AND ECONOMIC STUDIES

28. The Agency has undertaken a continuing programme of general technical and economic studies concerning nuclear power.

A. Technical studies

29. By the time this report is examined by the General Conference, the Agency will have held an important scientific conference on the subject of small and medium power reactors with particular emphasis on their possible utilization in under-developed areas.[7] It is intended that this conference will elicit and review the most up-to-date information available on the technology, economics and potential utilization of small and medium sized nuclear power plants. It will deal with three main topics, namely:

- (a) The technical aspects of small and medium power reactors, including the present status and future prospects of various reactor systems and concepts; experience gained in the construction, operation and maintenance of existing plants; safety aspects of nuclear plants; fuel cycling; and requirements and training of technical manpower for nuclear power plants;

[6] See GC(III)/76, paragraph 43.

[7] The conference will be held in Vienna from 5 to 6 September 1960.

- (b) Cost evaluation and economics of nuclear power with special reference to costing procedures, cost breakdown of different plants and potential reductions in nuclear power costs; and
- (c) The role of small and medium power reactors in meeting demands for energy, particularly in regard to power situations in less-developed countries.

30. About 200 participants from 50 Member States and six international organizations are expected to take part in the conference. The proceedings, including papers which may not be orally presented for lack of time, will be published.

31. In connexion with power reactor technology and economics, a scientific symposium on fuel element fabrication was held in May 1960 in Vienna. This symposium, which was attended by more than 150 participants, indicated substantial hopes for a reduction in nuclear fuel costs. The proceedings of the symposium are expected to be available early in 1961.

32. Following the offer made by the United States Government at the last session of the General Conference for the Agency to participate in the design, construction and operation of small and medium power reactors in the United States,[8] the Agency has established close contact with USAEC concerning this part of its programme. It is proposed to make full use of the offer by sending Agency staff members for short visits to follow up the development of this work, and the first such visit has already taken place. Besides gathering technical information it will be the role of the Agency to indicate to the reactor designers various problems which less-developed countries may face when building and utilizing such power plants.

B. Economic studies

33. In the course of its programme of economic studies the Agency intends to prepare a series of documents on the subject, with particular emphasis on nuclear power costing, which will serve as guidance to the power planning authorities of lesser developed countries wishing to assess the possibilities of the economic use of nuclear power.

34. The Agency's programme, to be complete, should cover costing at plant, power system, and country level. The studies might subsequently include:

- (a) A review of the present methods of presenting and breaking down the costs of nuclear power plants, and of determining the unit generating cost for a specific plant;
- (b) An investigation of methods of cost comparison between nuclear and conventional power stations, taking into account the future development of the power system in which they will be operated; and
- (c) A study of the economic problems involved in comparing the total cost of nuclear and conventional development programmes for a given country.

35. A panel of experts was convened in March 1960 for the purpose of carrying out the task mentioned in sub-paragraph 34(a) above. The panel agreed on a broad itemization of the costs likely to be incurred in a less-developed country starting to use nuclear power. It also provided advice on costs and on costing methods; and attention was drawn to the main uncertainties still associated with the cost of nuclear power. Wide differences were noted between Member States, particularly in respect of methods and costs of construction; the types of load system situations into which a first nuclear station would be connected; and the costs of borrowing foreign and local capital. The panel suggested that a meeting of experts specialized in the very complicated matter of costing nuclear fuel cycles be held

[8] See document GC(III)/COM.1/OR.22, paragraph 92.

during the coming year. Representatives from the United Nations, the World Power Conference and regional inter-governmental organizations also took part in meetings of the panel which will reconvene in late November 1960 to consider the draft of a first report on present methods of nuclear power costing.

36. In connexion with methods of comparing costs between nuclear and conventional power, it will be noted that the Department of Economic and Social Affairs of the United Nations Secretariat has initiated a similar costing study concerning conventional power. The Secretariats of the Agency and the United Nations have already undertaken to work in close relation with each other in order to achieve the fullest degree of compatibility in these studies.

V. CONCLUSION

37. As described in the preceding paragraphs the activities of the Agency in the development of nuclear power have consisted in initiating power surveys, making cost studies and convening scientific meetings on the technical and economic aspects of nuclear reactors, and in this way taking the first steps needed for its programme of assisting interested Member States. The difficulties which have been encountered by the Agency in carrying out this first part of its programme are largely due to such factors as the present status of nuclear economics, the lack of technical and cost data on nuclear plants, and the scarcity of information on the power situation in a number of Member States.

38. Technological developments and consequent cost changes occur at a much faster rate for nuclear power than for well established industries with a large fund of constructional and operational experience. It is therefore natural that Member States have stressed their desire to be kept abreast of the rapidly changing picture of nuclear power; they have also emphasized the need for investigating the particular conditions which the introduction of nuclear power in various areas of the world may have to meet.

39. The Agency has planned its activities accordingly. Such studies and investigations, carried out on as broad a basis as possible, are in the interest of all Member States. Under present economic circumstances, no effort should be spared to acquire and bring together the maximum amount of knowledge and experience in order to lower the cost of nuclear power and thus facilitate its future expansion throughout the world.

