

Nuclear power development in China

The country is seeking to develop a diversified energy base

by Zhou Ping

Energy availability is an important issue for economic development and higher standards of living. In line with worldwide population growth and the rise of living standards, global energy consumption has increased steadily. It has been estimated that conventional energy sources, such as petroleum and natural gas, would last only a few more decades at the present rate of consumption. With the depletion of conventional energy sources, and the technological development that has kept pace with it, the inevitable trend in energy supply has been, and will be, a move away from fossil fuels and towards a variety of alternative energy sources. In the course of this inevitable diversification, nuclear energy, among other sources, becomes an alternative that is practical and capable of supplying large amounts of energy required by mankind in the near future.

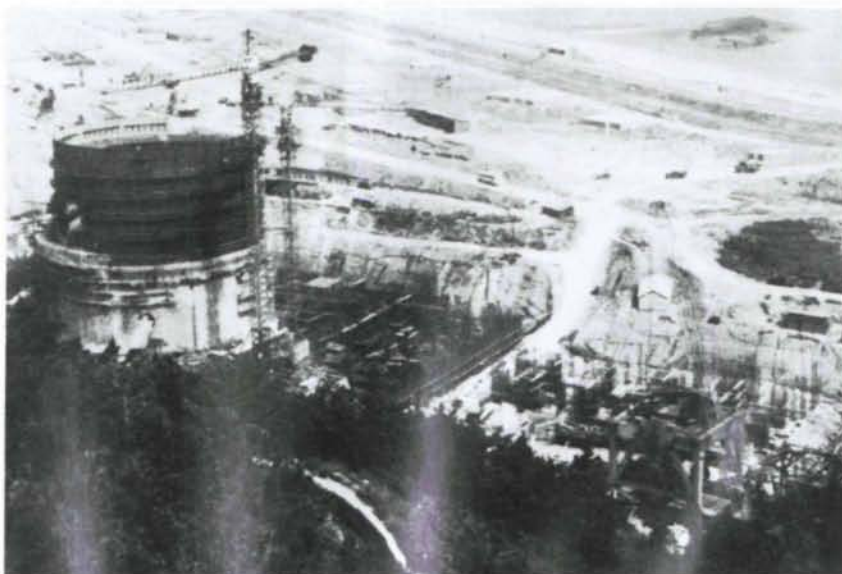
Nations around the world now accept nuclear generation, and it has become the general trend in energy development. In comparison with other forms of energy, nuclear energy now plays a progressively more important role around the world. Despite the accidents at Three Mile Island (TMI) and Chernobyl, the historical course of development in energy has not been altered.

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China's need to develop nuclear power

An overall economic development programme has been drawn up in China for the complete achievement of the Four Modernizations of Socialism. The implementation of this plan depends primarily on energy development. It is commonly known that China possesses abundant energy resources, but due to a large population, per capita energy consumption is low. The situation is further aggravated by an uneven distribution of energy resources: 80% of proven coal deposits are located in the northern part of China. South China, comprising eight provinces, contributes only 2%. Regarding hydroelectric resources, 70% are concentrated in southwest China. While the three major regions (East, North-east and South-Central China) account for 63% of the population and 65% of the nation's energy consumption, they only have available to them about 15% of the country's energy reserves.

This has resulted in an inequitable situation, where economic development in China has tended to concentrate in the East, while most energy resources lie in the West. This paradox was partially solved in the past by transporting coal to the South from the North, and transmitting electricity to the East from the West. Such measures, of course, caused overloading of China's transportation system, and cities in southeast China



Site of Qinshan nuclear power plant construction.

remained hampered by a serious undersupply of electricity. For example, the economically developed province of Guangdong has a per capita energy consumption of 350 kilowatt-hours per year, which is lower than the national average, not to mention the energy consumption of industrialized countries. To fundamentally correct the inappropriate distribution and composition of energy resources, the Chinese Government has formulated a positive policy for developing appropriate nuclear power, taking into consideration the situation in China and energy development around the world. Specifically, this would mean that as it concentrates on the development of thermal and hydroelectric power, China would methodically develop suitable nuclear power, with emphasis on some selected projects. In the industrially developed coastal areas of southeast China, which suffer from transportation bottlenecks and a serious shortage of conventional energy, and in northeast China, where there is a concentration of energy-consuming heavy industry, nuclear power would be developed to supplement the existing inadequate supply of energy.

National experience and capability

China possesses over 30 years of experience in the nuclear industry. The technology and material means for developing nuclear power is on hand because:

- China has fairly abundant deposits of uranium, which forms the necessary material basis for developing nuclear power.
- With respect to a nuclear fuel industry, China has already built up a fairly complete fuel cycle, ranging from uranium geology and exploration, uranium concentration, reactor fuel element manufacture, and reprocessing of spent fuel elements.
- China has acquired definite experience in the design, construction, and operation of reactors. Using her own technology, China has designed and built over a dozen different types of reactors, such as production reactors, research reactors, and power reactors. In reactor operation and safety, 160 reactor-years of experience have been accumulated.
- An experienced and well-trained team of professionals, covering a wide field of expertise, now exists within the country. They are able to meet the needs of the nation's nuclear power development programme.
- A series of educational institutions now exist that form the basis for the training of nuclear specialists, covering a wide field of expertise. Well-known institutions of higher learning, such as Qing Hua and Beijing universities, have trained a large number of specialists and technologists for the nuclear industry.
- In the development of her nuclear industry, China has attached special importance to extensive international co-operation and exchange, thereby mastering advanced experience and technologies in the international scene.

All these points form a solid base for China's development of nuclear power.

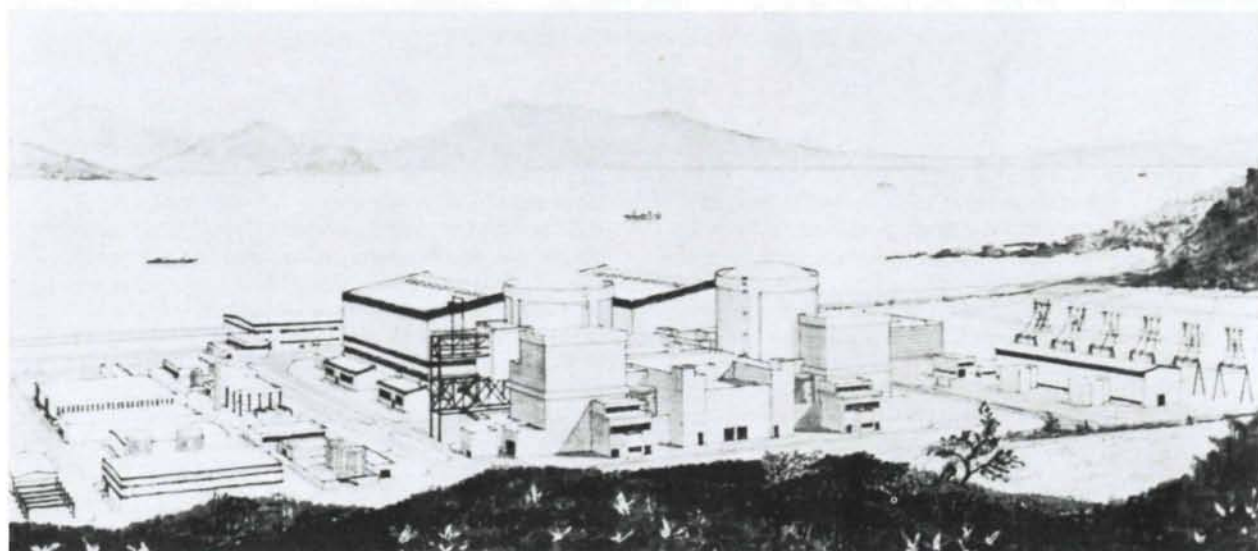
Status of nuclear power in China

Qinshan project. In accordance with the general policy of positively developing appropriate nuclear power, China's nuclear development programme is proceeding methodically, with emphasis being placed on selected projects. In June 1983, national construction started on a self-designed 300 megawatt-electric (MWe) nuclear power plant, a pressurized-water reactor (PWR), in Qinshan, Zhejiang Province. As of October 1986, the pouring and reinforcing of concrete for the reactor containment, and the welding of the steel lining, had reached elevation levels of 34 and 42 metres, respectively. The entire project is progressing smoothly on schedule. This nuclear power plant is planned to be put into operation in 1989.

Daya Bay project. The nuclear power station at Daya Bay in Guangdong Province comprises two 900-MWe PWR units. This is a large sized power station being built with foreign investment and imported equipment and technology. The GNPJVC, the acronym for a joint company, would be responsible for its construction. The nuclear island will be supplied by the French company Framatome, and the conventional island by the British General Electric Company. Electricité de France will assume responsibility for overall project technical services. The Bank of China has been entrusted with the responsibility of arranging the finances for this project from foreign banks. All contracts relating to this project were formally signed in Beijing on 23 September 1986. These contracts related to equipment supply, project service, nuclear fuel assemblies, and loan agreements.

This marked the beginning of the new stage of overall construction, the conclusion of contract negotiations lasting approximately 8 years, and preliminary project preparations. The contracts stipulate that the two units of the Guangdong nuclear power station should be put into commercial operation in 1991 and 1992, with an annual generation of 10 000 million kilowatt-hours. Of the energy generated, 70% will be sold to Hong Kong at a competitive price, while the other 30% will be fed into the Guangdong network. Without doubt, the completion of the Guangdong nuclear power station will play an important role in contributing to the prosperity and stability of the Hong Kong region, as well as to the economic development of Guangdong Province.

During the Seventh Five Year Plan, in addition to the projects at Qingshan and Daya Bay, two nuclear power units, each 600-MWe, are contemplated at the same site as the 300-MWe Qinshan nuclear power plant. The China Nuclear Engineering Corporation, under the Ministry of Nuclear Industry, will be responsible for the second phase of construction at the Qingshan nuclear power plant. The policy to be followed will be one of basic self-reliance, with the assistance of international co-operation; i.e. the major equipment will be Chinese, but some equipment will be imported. This project will be completed and put into commercial operation soon after 1993. Preliminary preparation is now proceeding.



Guangdong nuclear power plant, planned for two 900-MWe units.

Future prospects and plans

As previously mentioned, the general policy for nuclear power development in China is to positively develop appropriate nuclear power. In the near future, it is not expected that nuclear power plants will be built in large numbers, or at high speed, mainly because abundant hydroelectric and fossil resources are available. An additional important reason is that nuclear power involves huge investments, long construction periods, and requires high safety standards. Following the TMI and Chernobyl incidents, countries around the world increasingly realize the importance of safety in nuclear power plants, and, obviously, investments will increase due to requirements of higher safety standards.

China is a developing country and committed to the overall achievement of her socialist modernization programme. This needs large investments in every area. China recognizes, however, her actual financial position, and only limited financial and material resources can be allocated for nuclear power development, especially in the immediate future. During the Seventh Five Year Plan, it is desirable to build only a few nuclear power plants, step by step, in a planned way. The nuclear power to be generated by these plants can be used as a supplemental energy source. And through their construction and operation, technological experience will be accumulated so that a sound base can be formed for greater development in the 21st century.

Nuclear power is an energy source with bright prospects, and the technology is developing all the time. In addition to advanced nuclear power plants, China will also positively develop other new types of reactors and other new technology, such as the fast breeder reactor

(FBR) and high-temperature gas-cooled reactor (HTGR). At present, valuable work in exploration and research is being conducted in these fields.

It is well known that China is firmly implementing the policy of opening to the outside world, while proceeding with her Four Modernizations programme. This policy will also guide the development of nuclear power. In line with the principle of basic self-reliance, and with the assistance of international co-operation, China will positively introduce advanced equipment and technology, along with experience in operations management, financing, and professional personnel. Through joint design and production, China can gradually become basically independent in the manufacture of nuclear power equipment.

China has always pursued the policy of "giving first priority to safety and quality" in her nuclear power development. A nuclear power plant is a project that is knowledge-intensive, technology-intensive and capital-intensive. Furthermore, it needs not only close co-operation among the parties concerned in China, but also an extensive exchange of international experience and co-operation. The purpose of China's nuclear power programme is to utilize atomic energy for peaceful applications, and to bring its benefits to the people.

The People's Republic of China has already announced that the Guangdong nuclear power station will be the priority project to be voluntarily offered to the IAEA for safeguards. China sincerely hopes to exchange experience in the peaceful applications of nuclear energy with other countries around the world. China welcomes foreign companies and suppliers to establish sincere co-operation in many areas and different forms.



Impressions and expectations

Reflections on the occasion of the IAEA's 30th Anniversary

by Zhou Ping

On the occasion of the 30th anniversary of the founding of the International Atomic Energy Agency (IAEA), may I use this issue of the *IAEA Bulletin* to express my warm congratulations. I heartily appreciate those colleagues of all countries who have made great contributions to the healthy development of the IAEA, as well as the Secretariat of the IAEA that has worked diligently under the leadership of three successive Directors General.

A 30-year period is only of short duration in human history, but just in this period, a treasure house of human science and technology has been accumulated. As for nuclear science and technology, if we take the discovery of natural radiation by Professor Becquerel in 1898 as the starting point, a 90-year course has been established. Thanks to the great efforts made over several generations, especially in recent decades, it can be said that humankind has successfully mastered nuclear energy and can use it on a large scale. There are more than 530 nuclear power reactors that are operating or under construction in more than 30 countries and regions through the world. The total rating power is about 400 gigawatts-electric. Nuclear power has made great contributions to progress and civilization. The achievements in nuclear science and technology are the outcome of positive efforts and full co-operation of nuclear scientists, engineers, and others who have supported nuclear energy development and utilization.

The development and utilization of nuclear technology was the foundation for the establishment of the IAEA in 1957. The Agency's growth is synchronous with the technical development and maturity of nuclear energy and the use of isotopes. In the past 30 years, the IAEA has played a positive worldwide role in the promotion of the knowledge of nuclear science and technology, in exchanging the research outcome of nuclear scientific experiments, in exchanging experiences for the develop-

ment of the nuclear energy industry, and in promoting technical co-operation among its Member States. Simultaneously the IAEA has done much beneficial work on nuclear technical safety standards, regulations, codes, guides, and relevant safety procedures and guidelines. This work has strong appeal to a vast number of nuclear scientists and to those who are concerned with the utilization of nuclear energy. Therefore, the IAEA has enjoyed great prestige. At the same time, people have paid attention to the IAEA's fulfilment of its duty in the area of safeguards for the peaceful use of nuclear energy.

The modernization of China's socialist construction is now under way. China has devoted much attention to the peaceful use of nuclear energy and its support throughout the world. The experiences for developing nuclear energy should become the common wealth of human beings. We can draw lessons from the setbacks and experiences for reference. Nuclear energy technology is complicated in technique and sensitive in politics, so it makes people pay close attention to international co-operation. It is right that the IAEA provides conditions for discussing common issues of nuclear energy development that are faced by all countries in the world, for exchanging opinions and experiences, and for developing co-operation. We pursue the policy of international co-operation while mainly relying on our own efforts in developing our nuclear energy. I am sure that the admittance of China into the IAEA will play a positive role in promoting the development of nuclear energy's peaceful use in our country.* At the same time, China can also contribute its share for the promotion of international co-operation through the IAEA.

In the past years, our experts and officers have already developed co-operative exchanges in various fields of nuclear energy with experts of the IAEA and its Member States. As a new member of the IAEA, our experts have taken part in various Agency activities. We have a good impression of these activities organized by the IAEA. Of course, it takes time to study, and more practice, in order to make a complete evaluation. As I am one of the Governors on the IAEA Board of Governors, I have heard that someone has two sayings from inside and outside of the IAEA. They are: "The Agency is the arena for the promotion of international co-operation, and the Secretariat, for this purpose, shall do its utmost to serve its member countries"; and "The Agency shall pursue the principle of reaching unanimity through consultation in dealing with issues." I commend these sayings, and expect that the Agency will achieve even more.

The aim of the Agency is to speed up and expand the contributions of atomic energy to world peace, health, and prosperity. The aim expresses the common wishes of nuclear scientists in our country and the world. It can be believed that the Agency will continue to do its utmost to pursue it. And I am willing to do my part for this aim.

* China became the IAEA's 112th Member in January 1984.



Attending the IAEA General Conference for the first time in 1984, Mr Zhou (center) and other delegates from China were warmly received. Mr Zhou is Vice Minister, Ministry of Nuclear Industry and China's Governor to the IAEA Board of Governors.