# Notes from abroad

# FRANCE

## Atomic Energy Developments, 1946-50

*This report of a lecture which Dr. L. Kowarski gave at the National Museum of Science and Industry in South Kensington, appeared in* Nature *for March 11, 1950. It is reprinted here with the kind permission of the Editors.*

At the concluding lecture of the series held at the Science Museum in connection with the recent exhibition of French scientific instruments (see *Nature*, March 4), Dr. L. Kowarski gave an account of "Atomic Energy Developments in France, 1946–50". Introducing him, Sir John Cockcroft reminded the audience that Dr. Kowarski, together with Dr. H. Halban, had left France in 1940, bringing to Britain the world's largest single supply of heavy water, and that he had achieved outstanding work in the study of heavy-water moderated reactors.

Dr. Kowarski said that the French Atomic Energy Commission (Commissariat à l'Energie Atomique) was set up immediately after the Hiroshima incident and the consequent freeing of the basic information on new atomic energy studies. The provisional French Government of 1945 entrusted Joliot-Curie with the task of initiating the Commission, establishing its terms of reference, and directing it as High Commissioner. The first stages occupied some months, and the Commissariat à l'Energie Atomique came into active existence in March 1946.

The Commissariat had to form an estimate of the factors, advantageous and otherwise, which would determine its future course. In view of the international situation, work had to be undertaken independently of any other country and using only those resources available within French territory. The scientific and technical information available in France was much less than that in Britain and the United States, which meant that much pioneering experimental work would need to be undertaken. The state of France's economy during 1945–46, with industry disorganized and basic reconstruction claiming first priority, was not likely to promote quick results. The mixed character of that economy, with agriculture playing a very important part, meant a lower industrial potential, and therefore a smaller opportunity for rapid progress. Again, the French leaning towards abstract studies in the universities meant that, in comparison with conditions prevailing in Great Britain, men were not easily to be found who would have a ready understanding of the concrete problems of handling the special materials of atomic research.

In the balance were to be set some advantages. The very state of flux of French life was conducive to speedy administrative decisions. Everywhere, the spirit of reconstruction, especially among the young, was favourable to new departures. Years of instability had fostered an adventurous spirit, which could now be put to good use. The scientific tradition in the study of atomic physics was inspiring, since France might fairly claim to have cradled nuclear physics and radiochemistry. The chief favourable factor, however, was the presence in France of a handful of men with the right kind of experience.

Industrial support was essential, and France was fortunate in having in an advanced state a few of the special industries needed for basic supplies. A fairly pure kind of graphite had long been made, and a possibility of further refinement was immediately available. Nonferrous metallurgy—an essential part of the new large-scale nuclear engineering—was well established. To support all this, France had an excellent chemical industry with the right experience in the preparation of fine chemicals.

The prime object was a nuclear reactor. To achieve this object a long chain of preliminaries was needed. First, there had to be a laboratory for exploratory experiments, then workshops for the making of special tools which in turn could be used for the making of special instruments. All this had to be built up from nothing.

A site was chosen: the abandoned fortified structure of Châtillon. Existing buildings were adapted and new buildings erected. In the face of a European shortage, sufficient machine tools were obtained and installed by May 1946. In July 1946, the first production of counters was set on foot, the right man again, by good fortune, being available with a background of electronic experience gained in radar work in Great Britain. The Collège de France supplied the basic design of counting and amplifying apparatus, and soon it was possible to send out groups of technicians to prospect for uranium in Metropolitan France and the overseas territories.

At the same time, work was begun on the construction and equipment of analytical chemistry laboratories. This was essential because of the importance of pure materials and their control. The analytical chemistry project, in fact, commanded the first priority for some months until resources were adequate. Simultaneously, however, a

small factory was being set up to produce pure uranium in ton quantities, but of high purity. The factory project had to be conceived on new principles, and even though an experienced man was available to guide its planning, a year or more was needed for its completion.

The projected reactors needed men of a new kind. One may call them neutron engineers, and think of them as resembling the new electrical engineers who were called into existence eighty years ago, then as now, for the understanding and exploitation of a newly discovered force in nature.

All the time, prospecting for uranium was going steadily on, new sources being sought and known ones assessed. A deposit of a fairly rich ore was found in France, sufficient in quantity to ensure the existence of the Commissariat à l'Energie Atomique for some years. On a quite different plane, use was made of this exploratory period to establish a legal framework for atomic energy work in France; progress in this direction, however, was somewhat hampered by external circumstances, and several essential features remain in need of a final clarification.

In the autumn of 1947 work was begun on the construction of a nuclear reactor. As is always the case, initial ambitious ideas had to give way to more modest ones, and the design finally embarked upon was for a reactor operating at only a few kilowatts. In addition, the difficulties of making pure uranium metal meant that the reactor had to operate on uranium oxide, which could be more easily made of the requisite purity. Heavy water was used as the moderator, and at the end of 1948, after sixteen months work, and after three years of the existence of the Commissariat, the machine ZOE (Z for 'zero' output, O for oxide of uranium, E for 'eau lourde') was ready to operate. It is now being shown to the general public, and such visits are considered as being outside the scope of the secrecy regulations. It develops some 5 kilowatts only, but because of its reduced bulk, the radiation intensity achieved is nearly equivalent to that of high-powered graphite piles, such as the British GLEEP.

During the past two years, work has been actively proceeding on the building of two accelerators, one a cyclotron, the other an electrostatic machine. Neither is yet ready, but it is hoped that the electrostatic machine may be ready in its essential features this year, and the cyclotron next year. The uranium factory has been equipped for the extraction of the plutonium which is produced in the pile. The plutonium is extracted for scientific interest only. Any thought of French atom bombs will be dispelled if one remembers that, to produce enough plutonium for one bomb, the only pile in France would have to operate for many hundreds of years.

A larger reactor is now under construction, in which it is hoped to achieve a higher radiation intensity than in the second British reactor. This reactor should be ready in 1951 or 1952. It is being built at a new atomic energy center at Saclay, twelve miles from Paris, which will also house the two accelerators and other new equipment. Work on it goes forward while mining projects are pressed on at the deposits in the south-west of France.

Men are needed as much as equipment, and to produce the new nuclear physicists, teaching will have to be intensified; for some years this may well turn out to be the most important task of the Commissariat. For the work these new men will do new materials will be needed, so new facilities for the production of pure substances will have to be brought into being.

The results already achieved are beginning to be influential outside the limits of the organization itself. The nuclear reactor is, of course, a source of radioisotopes which can be used in many branches of research. The Commissariat à l'Energie Atomique aims at fulfilling all French requirements, but it has to be admitted that at the moment British competition must be reckoned with, owing mainly to the higher intensity of the available irradiation. Outside workers' materials can be given neutron irradiation as at Harwell. The Commissariat is also acting more and more as an information center on matters not necessarily connected with atomic energy, but contributing to its study, and on which experience has been accumulated in the organization. Some of these techniques have not otherwise been studied in France. Examples are high-vacuum technique and powder metallurgy. Naturally, advice is also readily available on research techniques employing radioisotopes. It is hoped that this influence will eventually be felt beyond the borders of France.

Some people express the hope that there might be a joint European effort at investigating and exploiting atomic energy. France would presumably play a leading part in any such joint effort on the Continent. So far, there is little sign of an international organization coming into being. This is to be regretted for many reasons, among which is the loss to the common effort of the experience of countries with particular resources. For example, Switzerland or Sweden could build a powerful synchrotron, to be used by all European scientific men, with their highly developed electromechanical industry. The obstacles to joint effort are those customarily met, to which is added a specific inertia encountered whenever atomic energy is considered in the light of any one nation's national defence. Governments have been generous to atomic energy projects because of its supposed military significance, but loss of control is resisted. The physicist who looks for freedom from control may therefore also risk losing patronage.

The immediate future in France is clear. It is simply to develop the new center at Saclay with all its requirements. What might come after, say in the development of useful industrial power, will be determined by the financial support to be obtained, and no one country in Europe can easily provide enough on its own. In the long run, a choice will have to be made in France between: (1) an effort to broaden the international basis of atomic energy work; (2) going on in isolation, but with a greatly intensified effort; (3) or keeping the fire of interest and experience just alive with a reasonable minimum of experimental fuel until better days come. To the question of what choice will be made, it is too early to suggest an answer.