Report by the Three Wise Men on Euratom (4 May 1957)

Caption: On 4 May 1957, the Committee of Three Wise Men (Louis Armand from France, Franz Etzel from Germany and Francesco Giordani from Italy) submits its report entitled 'A target for Euratom', which reviews Europe's needs and its resources in the field of nuclear energy, to the governments of the six Member States of the European Coal and Steel Community (ECSC).

Source: ARMAND, Louis; ETZEL, Franz; GIORDANI, Francesco. A target for Euratom, Report submitted by Mr. Louis Armand, Mr. Franz Etzel and Mr. Francesco Giordani at the request of the governments of Belgium, France, German Federal Republic, Italy, Luxembourg and the Netherlands. [s.l.]: May 1957. 104 p. p. 13-40.

URL:
http://www.cvce.eu/obj/report_by_the_three_wise_men_on_euratom_4_may_1957-en-e72917a4-3c9d-48b1-b8cb-41307736731e.html

Last updated: 05/11/2015

A Target for EURATOM

Preface

On November 16, 1956, the Ministers of Foreign Affairs of Belgium, France, the German Federal Republic, Italy, Luxembourg and the Netherlands instructed us to report ‘on the amount of atomic energy which can be produced in the near future in the six countries, and the means to be employed for this purpose’.

On March 25, 1957, the Treaty instituting the European Atomic Energy Community (Euratom) was signed by the same Ministers in Rome and is now being submitted to the parliaments of our six countries. In the hope that this Community can begin to function in the very near future, we have entitled our report: A Target for Euratom.

While endeavouring to define this objective, we have been aware of the unique chance which the advent of nuclear energy offers our countries. Only ten years ago, Europe seemed to be condemned to have less abundant and more expensive energy than the United States; nobody would have imagined that this opportunity would emerge. Today, it can be said that if our countries, guided and stimulated by Euratom, make the necessary effort they will in future command — as the New World does now — abundant and cheap energy supplies, enabling them to enter boldly into the atomic era.

Establishment of a Target

Europe’s Energy Problem.

In the 19th century coal, produced cheaply and abundantly, multiplying a hundredfold the effectiveness of human effort, turned Europe into the ‘workshop of the world’. In the last five years of postwar expansion, Europe has suddenly discovered that this favourable situation has entirely changed and that a new fact conditions all its prospects: the shortage of energy threatens to become a major brake on economic growth. This is the context in which the new prospects opened up by nuclear power must be assessed. It has become a practical possibility at a turning point in Europe’s economic history.

In 1870, total world energy production amounted to 218 million tons of coal. Of this, the United Kingdom and our six countries together produced three-quarters. The story of the industrial development of the nineteenth century is bound up in these figures. Britain and the Continent not only powered their own unprecedented industrial progress; they were the great exporters of energy and its products to the world.

Unfortunately, if Europe’s internal resources of energy were abundant by the standards of 1870, it is becoming clear that by the far higher ones of 1957 and still more of 1970, they are, and will be, increasingly inadequate. Though today our six countries alone mine more coal than the world did in 1870, they provide only 15 % of world energy production. The rapid growth of their imports since the war shows that Europe’s own supplies of all kinds of energy are falling far behind demand.

On the eve of the Second World War, our six countries’ energy imports were only five per cent of total requirements. During the postwar recovery they began to rise steeply. This was generally assumed to be temporary, while European coal production got back on its feet. And, indeed, in 1950 something like the pre-war equilibrium seemed to be within reach. But now, after the growth of the last seven years, it is clear that the demand in industry and transport, in the home and in agriculture is rapidly outrunning internal supply. Europe has lost its independence in energy.

The greatest possible effort to increase the output of energy from conventional sources must be undertaken in our six countries. But, however great this effort, it cannot keep pace with our needs. The conditions in which coal is mined, much less favourable to mechanization than in the United States, slow up the possible rate of growth. As more coal is sought, the veins to be exploited become deeper and more difficult to work, setting a limit to the further expansion of output. The same applies to hydro-electric power, the resources of

which have been already largely developed. As for oil and natural gas, the prospects in our countries are good, but not by any means on a scale to bridge the gap between needs and supplies.

Europe's energy imports would rise to intolerable heights without nuclear power. Today already the six countries import nearly a quarter of their energy supplies, the equivalent of 100 million tons of coal, most of which is oil from the Middle East. The Suez Crisis has shown how precarious these supplies are.

For the future, we have assumed the greatest possible development of conventional power sources, and have based our estimate of energy requirements on a moderate but steady rate of economic expansion which is considerably slower than that since the war. Every effort has to be made to increase domestic production, but it must be realized that even on this assumption fuel imports into our countries would double in ten years and treble in twenty. They would reach 200 million tons (33 % of total requirements) in 1967 and might reach 300 million tons (40 %) ten years later.

These enormous figures in fact call in question the whole future of Europe's economic growth, and even of its political security in the world. First, they imply an annual bill for energy imports rising (in round figures, at constant prices) from $ 2 billion now to $ 4 billion by 1967 and $ 6 billion by about 1975. Even taking into account the part of this bill met in national currencies, especially through the contribution of our merchant marine, the need for foreign exchange would put a most severe strain upon the balance of payments of our countries. The need to earn this additional foreign currency would also involve very important investments in export industries. And the increased pressure to sell on the world market would tend to push the terms of trade against Europe, a point of vital importance to the world's greatest trading area.

A second, still graver threat is the evidence, provided by recent political events and the ensuing oil shortage, that even the availability of imported energy is uncertain. Oil already provides over a fifth of our countries' energy supplies. It is cheaper per calorie than imported coal, and it is more convenient to handle and use. It is therefore likely that most of the increase in the demand which must be met by imports will take the form of oil.

We cannot expect to obtain this oil from the Western Hemisphere because demand there is rising faster than production. The only region of the world capable of supplying these quantities is the Middle East, where a very high proportion of world oil reserves is located. The oil discoveries in the Sahara are promising, but it can hardly be expected to provide more than a fifth of our energy imports by the mid-sixties. Thus without nuclear power, Europe's dependence on the Middle East is bound to increase. The Suez Crisis has given us a warning of what this could mean. As the quantity of oil imported from the Middle East increases, there will be a corresponding increase in the political temptation to interfere with the flow of oil from that region. A future stoppage could be an economic calamity for Europe. Excessive dependence of our highly industrialized countries on an unstable region might even lead to serious political trouble throughout the world. It is essential that oil should be a commodity and not a political weapon.

The European economy must be protected against an interruption of oil supplies, by finding alternative sources of energy to limit the further rise in oil imports. Only nuclear power, providing Europe with a new source of energy, can achieve this.

Scope for Nuclear Power.

Though it may be used to propel ships and to heat urban areas, the real contribution of nuclear energy in the next twenty years will be to produce base-load electricity in big power stations.

Electricity consumption is growing rapidly, doubling every ten or twelve years. To cover this new demand, the domestic sources of energy specially adapted for power production (water, lignite, low-grade coal and natural gas) must be developed to the utmost. Even so, they cannot together meet more than one-third of the increase of electricity needs in the next twenty years. Two-thirds of the additional output must come from

power stations fired with imported oil or coal, unless nuclear stations are built in their stead. The increase in production of saleable coal will be absorbed by other uses, especially for coke-ovens. The capacity of such power stations is estimated to rise by 22.5 million kW, from 38 million kW at the end of 1960 to 60.5 million kW by the end of 1967, apart from replacements amounting to more than 5 million kW in this period. This is the field into which nuclear power can be fitted.

Every year that is lost in constructing nuclear power stations means that conventional stations, requiring increased oil or coal imports — and which continue to consume oil or coal throughout their lifetime of twenty or thirty years — will be built instead. In view of this situation, Europe must within the limits set by the pattern of electricity production, construct nuclear stations as rapidly as possible.

Nuclear plants take up to four years to build. Although some already under construction (such as the French power plant, E.D.F. 1), or shortly to be ordered, should come into operation in 1961 and 1962, nuclear power cannot be expected to provide a big contribution before 1963, since orders cannot be placed for substantial construction of plants before the end of 1958. Further, industry will need time to build up capacity before it can provide all the nuclear plant that could be used. Industrial firms will have to adapt their staffs and their production facilities to a new technology on a big scale. This means that we must expect a progressive build up in the rate of construction of nuclear power stations. This delay will enable us to reach decisions on the basis of two or more years experience from the big nuclear power stations now under construction in the United States and the United Kingdom.

In view of these considerations, we estimate at some 15 million kW the nuclear power capacity that can be accommodated in the electricity system of the six countries during the next ten years. If this can be done, it will stabilize imports at the level they would otherwise reach in 1963 of around 165 million tons of coal equivalent a year.

This is an ambitious target. It will call for a great, continuous effort, since our industries, with the exception of the French, have had practically no experience in the nuclear field. Moreover, far from conflicting with an all-out effort to increase the output of conventional forms of energy, it is only by close collaboration between all methods of producing electricity that this target can be attained and the level of imports stabilized.

Great Britain has already faced a similar issue, and has come to a similar conclusion. She has in fact reacted very quickly to an energy problem that is less threatening than our own. Britain to-day imports only 12 % of her total energy requirements, while we import 23 %; in ten years' time these imports, if not checked by nuclear power, would rise to 22 % in Great Britain, against 33 % in our countries. Her programme of 6 million kilowatts by 1965 is expected to stabilize fuel imports from 1960 onward. The 15 million kilowatts which we are taking as our 1967 target can achieve the same result for us in 1963.

This target is two and a half times the British programme, which seems reasonable when we consider that the ratio of population is 3 to 1, and that of electricity output 2.8 to 1, and that, as mentioned above, the six countries are starting out from a far less favourable position than Great Britain in the matter of energy imports.

It is not for us to translate this target into a programme. Without doubt our target is far larger than the sum of the existing plans prepared separately by our six countries, plans which would involve the installation of about 6 million kilowatts capacity between now and 1967. Incidentally, it has been possible to see since our investigations began — perhaps it should be regarded as one of their first results — a very marked tendency for each country to expand its programme.

We also had to compare our target and the programme it entails with the industrial resources available in our six countries for the building of reactors. The British experience is the only one to which one may refer in order to have an idea of how industry can be adapted to an important atomic programme. In Great Britain, it is considered that, by 1965 (the execution of the British programme was started in 1955), industry will be in a position to install 5 to 6 m. kW of nuclear energy and, moreover, be able to export the same amount,

totalling 10 to 12 m. kW of nuclear power capacity. The engineering industries of the six Euratom countries have an overall capacity which is approximately 1.6 times that of the same industries in Great Britain. On this basis, one can therefore consider that — given an effort comparable to that undertaken by Great Britain — our countries should be able to build over 15 m. kW of nuclear energy in the course of ten years.

This is, of course, an appreciation of our nuclear possibilities. As in any big industrial development, bottlenecks are bound to appear. The part which the United States, Great Britain and Canada play in the way of cooperation with regard to processing, fuel, reactor components etc., will therefore consist not only of facilitating our effort from a general point of view, but also of helping us to overcome the temporary difficulties which may arise at the start in various fields. Although our 15 m. target is ambitious, it is compatible with the industrial potential of our countries, taking into account the help we can expect from Great Britain and the United States.

Euratom will create new opportunities. It will pool the scientific as well as the industrial resources of our six countries and their varied skills. A common market for nuclear equipment to be set up within a year will promote industrial specialization. Further, Euratom will represent our nations as a single unit vis-à-vis other states, and will be far better placed to obtain full cooperation from then than our countries separately.

Our enquiry abroad has already shown the expanded opportunities for outside help opened up by Euratom. The contribution in nuclear fuels, reactor technology and components can make the difference between a rapid and a slow European departure in nuclear power production. To take one concrete example: the scarcity of trained technicians could seriously hamper the rapid execution of a big programme. During our visit to America, Britain and Canada, training facilities were offered to Euratom on a scale never contemplated for our individual nations.

A critical moment has been reached: atomic power is coming of age. Nuclear power has moved out of the scientist’s laboratory onto the engineer’s drawing board; it will now come quickly into commercial phase. This provides a great opportunity for our countries if we seize it and a grave danger if we do not. Scientific and technical knowledge can be borrowed; but industrial capacity one must create oneself. If our industries do not go ahead on a big scale now, at a time when others are poised to do so, they will soon be unable to face competition from the full-grown industries which have seen and seized their chances in time. Later development would only be possible behind protective walls with all the drawbacks they involve. In view of the growing importance of atomic techniques for industry, Europe, as the world’s greatest exporter of engineering goods, cannot afford to miss the chance to move off to a rapid start.

So long as we act with drive and determination, the possibilities created by Euratom give us every hope of meeting the challenge of the atomic era, and, in so doing, of resolving our energy problem.

Conditions of Achievement

The scientists of our countries made fundamental contributions to the discoveries on which nuclear power prospects are based. But, as a result of the war and their divisions, they have taken little part during the last fifteen years in the massive and costly build-up of the foundations of nuclear industry. France has already begun to apply nuclear power on an industrial scale, and Germany, Italy, Belgium and the Netherlands are actively engaged in power projects and reactor development. But these efforts fall far short of what Britain, not to speak of the United States, has done to lay the basis for the commercial application of nuclear power. If our industries had, today, to start entirely on their own, an unduly slow and costly growth would be unavoidable. The American interest in the world-wide extension of atomic energy for peaceful purposes to which President Eisenhower’s ‘atoms for peace’ programme testifies, has relieved our countries of some of the penalties of their handicap.

Cooperation with the United States, the United Kingdom and Canada.

The United States government showed a keen interest in the prospects of a big Euratom programme for the

production of nuclear energy. Their well-known support for European unity and their interest in Europe's economic strength and stability explain this welcoming attitude. Europe can help America in the future as America is prepared to help us now. The average cost of electricity in America is about two-thirds of what it is in Europe, so atomic power will compete in Europe long before it can do so in the United States. An impressive amount of research and development done both through the Atomic Energy Commission and by private industry have provided America with the most complete nuclear foundation in the world. But the large-scale application of this immense potential appears to be at least five to ten years off. Europe, on the contrary, needs atomic energy right now. No amount of research can be a substitute for the practical knowledge to be gained by the large-scale industrial application of atomic power. Europe could make this experience available to the United States. Our talks in Washington convinced us that, on the healthy basis of a two-way traffic, a close partnership as equals can be built up between the United States and Euratom and their respective industries.

For peaceful purposes, our visit provided indications of how the partnership would work. The United States would make available the necessary fissile materials and the technical knowledge to set our industries going. Once Euratom is established, a task force composed of some of America's most able men would be at out disposal to continue studying with European experts the many technical problems posed by our programme. America would provide training facilities for our scientists and technicians. Joint projects, for instance to improve and adapt reactors, can be envisaged between American and European industries, as well as between the American and European Atomic Energy Commissions.

Britain has concentrated on a reactor type which is now fully in the commercial phase. The British authorities have declared their readiness to facilitate contacts between British firms and those in Europe interested in building this type of reactor. They are also willing to assist Euratom in the vital matter of training scientists and engineers, and in putting their experts at our disposal to study the technical aspects of our programme.

Canada is equally prepared to cooperate. It can do so in two important ways. To begin with, it is one of the world's major sources of natural uranium. It would be ready to provide natural uranium to supplement European resources, provided it receives notices several years in advance, and that any agreement with Euratom guarantees the use of the uranium exclusively for peaceful purposes.

Further, Canada has done important original work on a type of reactor which promises to be particularly well adapted to European requirements, combining as it does many of the advantages of the natural and slightly enriched uranium approaches followed so far by Britain and the United States respectively. This reactor is well into the development stage. We have every reason to believe that Euratom would find the Canadian authorities willing to cooperate on the construction of prototypes.

In consequence of the far-sighted view the United States, Britain and Canada have taken of their interests in cooperating with our nations in nuclear development, we have the assurance that a large nuclear programme would obtain not only the benefit of years of development in these countries, but also the material supplies and technical assistance indispensable to a quick start. This broad cooperation is being offered because Euratom gives prospects of joint action on a scale our countries individually cannot propose and has been made possible by the Euratom provisions for an effective system of control of fissile materials.

Agreements of association should therefore be concluded between these countries and Euratom immediately after its establishment. At the same time, close cooperation should be developed with neighbouring countries, particularly Switzerland, Austria and the Scandinavian States, through O.E.E.C. or in other ways.

Strong cooperative ties with other countries — by which we obtain, now and later, the help of those who have explored nuclear possibilities more fully than we have, and in return offer our help in future to them and to other interested nations — must be the foundation of Europe's atomic progress. Far from undermining our independence, it is the only way we can gain our place as equals in the field. The road to dependence would be the opposite one, to confirm our backwardness by resorting to the illusion of self-sufficiency. Cooperation with others will not limit our opportunities, but create new ones, so that our

industries can eventually acquire their own, distinct nuclear personality.

Reactor Construction.

Our inquiry has convinced us that, though there are at least a dozen prototype reactors in an advanced stage of design or under construction, only two types are ready for commercial use. One has been developed in the United States and the other in Britain and France.

The first is fuelled with slightly enriched uranium, and is cooled by water under pressure, or by boiling water. This system was originally developed for submarines, and one unit has been functioning without interruption in the Nautilus for nearly two years. The experience gained on this project gives great confidence in the reliability of this type of reactor. Full-scale commercial prototypes of both versions of these reactors are under construction, in several cases entirely by private firms.

The second type, developed furthest in Britain, is the gas-cooled reactor fuelled with natural uranium. Its prototype at Calder Hall has been working successfully for the last six months. Confidence in the performance of this reactor enabled Great Britain first to set up a nuclear programme in the beginning of 1955, and then, at the beginning of this year, to treble it. Several large stations are now under construction for the British electricity authorities. The first French reactors now functioning or being built are of the same type.

Attention should be given by European firms interested in building power reactors and by Euratom itself to the development of two other types, not yet in the commercial phase, but which appear specially appropriate for Europe: a version of the British gas-cooled reactor, operating on slightly enriched uranium, and the heavy-water reactor developed mostly in Canada. Joint projects might be launched by industry or Euratom to solve the design and development problems to be overcome before these reactors can become commercial.

To begin quickly we must either buy some reactors from the United States and the United Kingdom or build them under license. This will not involve accepting permanent industrial dependence. On the contrary, it will speed up our industries' nuclear education, and provide a basis of well tested experience to root and nourish their own original contribution. Even if the reactor itself has to be imported, a large proportion of each of the first nuclear power plants will be built by our own engineering industries, and the proportion of components that must be imported will quickly fall.

The industrial re-orientation required will undoubtedly raise difficult problems, but they may prove less intractable than is often thought. Intensive re-training of engineers and scientists will be needed, but both the United States and the United Kingdom are ready to help. Euratom must carry out training programmes with the facilities they offer, on top of those already existing in Europe, and those that it will itself create. Further, the number of trained men required to design and build proven reactors is smaller than that needed to develop entirely new ones. A high proportion of the construction work in nuclear power plant differs little from the tasks which engineering firms are performing today. The industrial groups which have designed and are now constructing power reactors in the United Kingdom started with limited nuclear experience 18 months before their tenders were submitted to the U.K. Electricity Authorities.

Euratom and its objectives will be the stimulus, guiding and enabling better use to be made of our industries. The standardization of reactor components and procurement contracts should be encouraged. Also, a certain amount of general coordination will be essential because a programme involving millions of kilowatts under construction at any one time, and requiring a wide range of new materials and components, might easily be thrown out of gear by serious shortages and costly delays. Industry, for example, should be informed of the need for big high-pressure shells for reactors at least four years ahead of delivery in view of the likelihood that its capacity for their manufacture would have to be expanded.

Fuel Requirements.

Fuel requirements will depend very much on the types of reactor chosen by the electricity suppliers. However, it is now already clear that the fuel required to reach the target envisaged for Euratom will be obtained without difficulty, since its requirements are a small part of world production of nuclear fuels during the period under review. The uranium production in our countries, although small at present, is expected to rise as prospecting extends the field of known reserves. Further we have assurance that, in Canada, natural uranium output can increase considerably if the demand is firm.

We also attach particular importance to the statement made by the U.S. authorities that they do not consider that nuclear fuels will be a limiting factor. This opinion has been inserted in the Communiqué which the Secretary of State and the Chairman of the Atomic Energy Commission issued jointly with us at the end of our discussions in Washington. As this statement comes from the country which is the world's biggest producer of enriched uranium, and one of the biggest of natural uranium, we can be sure that the availability of nuclear fuel will not limit the realization of our target.

Euratom's action on fuel supplies could be of decisive importance for our industries. The total expenditure on nuclear fuels in the ten-year period required to reach the target of 15 million kW would amount to about $ 2000 million. According to the Euratom Treaty, special fissile materials will be owned by the Community. Therefore Euratom will retain title of the enriched uranium it will put at the disposal of the users and may well finance both enriched and natural uranium centrally as is done domestically in the United States and the United Kingdom.

Fuel problems do not end with the supply of fissile material. Both natural and enriched uranium have to be fabricated into fuel elements before use. And after use they must generally be processed in chemical plants to recover the valuable fissile products still left in the spent fuel.

Undoubtedly, for the needs of the first nuclear power plants, fuel elements can be imported from abroad, and the spent fuel returned to be processed. Both America and Britain are willing to do this, and have indicated the prices they will charge. But it would be inconsistent with our need to reduce our dependence on costly energy imports to continue to rely on other countries for these services. Both operations require plants serving many reactors to be economic. If each of our countries were to act as separate unit, it would take many years before it would be possible to build these plants on an economic basis. The establishment of the European Atomic Energy Community will allow us to build both fuel fabrication and chemical processing plants as soon as a large number of reactors are being built.

Euratom could also construct a plant to produce the enriched uranium needed. Till recently, this seemed the only way to obtain it. But there is now no doubt that our countries can obtain enriched uranium from the United States in the necessary quantities, and at the low published prices. These low prices are a consequence of the vast size of American plants, the extremely low power costs in the areas where they are located, low finance costs, and a very highly developed design and technology. Enriched uranium produced in Europe would, therefore, probably cost two to three times as much.

The building of a Euratom diffusion plant has been advocated to avoid basing nuclear energy production on a material that must otherwise be obtained from another country. If important quantities of enriched uranium had to be permanently imported, this argument would carry weight. But several years would elapse before Euratom's diffusion plant could operate. And the future of enriched uranium requirements is very uncertain. Even apart from the prospect of breeder reactors, plutonium will be produced in the fuel of Europe's first reactors. It is very probable that we will find an economic way to use this plutonium, and so reduce our needs of enriched uranium. Other improvements in reactors may have the same effect. In the end, these developments might even enable power reactors of all types to be based exclusively on natural uranium with fuel recycling.

Therefore, while it is essential for our countries to study with the greatest care the economic and technical aspects of uranium enrichment, it should be noted that the decision to build a diffusion plant on a

commercial scale, which means a heavy investment of capital and would consume large quantities of energy, does not have to be taken before a programme for the production of nuclear electricity is launched.

Costs of Nuclear Electricity.

At what cost will electricity be produced by the nuclear reactors commissioned before the end of 1967? And how will this cost compare with the cost of energy obtained from the new coal- and oil-fired stations which would have to be built if nuclear plants are not erected instead? Certain general points must be mentioned.

In the first place: only very limited experience is available in regard to full-scale power reactors; nuclear electricity costs are therefore always estimates, never proven facts. After extensive checking and discussion, inter alia, with the experts whom the American Atomic Energy Commission and the U.K. Atomic Energy Authority so kindly put at our disposal, we consider those which follow to be reliable.

In the second place: the cost of electricity produced by a given reactor will not remain continuously on one level, but will follow a descending curve as the operating technique improves in the course of time. Cost estimates must, therefore, be based on the *average* estimated cost of the electricity produced by a nuclear reactor in the course of its life. Operating costs will be high at the outset of the operation, but will decline in the following years — to a lower level as operating conditions are stabilized. Even in the case of the first reactors, power costs will continue to fall gradually as the techniques of using fuel improve. Nuclear fuel costs are low — less than half the fuel costs in conventional plants — and the saving will apply only to about one quarter of total nuclear costs, though they could be significant. Unlike nuclear stations, the fuel costs of conventional plants must be expected to rise slowly but steadily, relative to the general level of prices.

In the third place: comparison with the electricity costs of conventional plant must be based on new conventional plant burning imported fuel, because we have seen that nuclear power plants will only replace those which would have to consume imported fuel. It is impossible to evaluate in terms of costs the increasing risk of a stoppage in the flow of oil from the Middle East. But electricity producers would be ill-advised not to take this risk into account.

In the fourth place: as it is unlikely that advanced reactors promising far lower power costs, will come into commercial use before the end of our ten-year period, we do not propose to discuss them. But all the best authorities agree that the cost of nuclear energy, even for current reactor types, will decline in the next ten to fifteen years.

Taking these general considerations into account, our conclusion is that the range of costs of electricity produced by nuclear reactors of both the American and the British type, may be estimated at 11 to 14 mills per kWh, while the cost of electricity from new conventional stations, which must use imported fuel, will be 11 to 12 mills per kWh. Further, while the cost range of conventional stations is moving slowly upwards, that of nuclear power is moving down. These figures do not apply to the few large reactors which will be brought into service before 1962, and which are more prototype than commercial in character.

In view of this cost comparison, it is clear that the time has come when nuclear power can provide an economic means to stabilize our energy imports. The long-term prospects of reducing production cost are not an argument for delay; on the contrary, a big commercial programme now is the best way to secure a solid basis for massive expansion later.

We must finally point out that the first orders should be placed by the end of 1958, when results of experience will be available, not only from Calder Hall, but also from Shippingport, which will influence the decisions for subsequent steps of the programme.

At this stage, it is necessary to start with big plants; but this does not imply that the six countries are in a position to commit themselves now on the plants to be constructed during the ten-year period.

Investments.

Fuel costs loom large in the cost of conventional power and play only a minor role in nuclear power. In the case of investment costs the opposite is true. The investment costs for nuclear plants, including fuel inventory, must be estimated for stations to be brought into service in the next ten years to average somewhat more than two and a half times the cost of conventional steam stations, with a gradual decline towards the end of the period. For 15 million kW the difference would approach $ 4,000 million, or between 1 and 2 per cent of the estimated total gross investments of our six countries together in the next ten years. This additional investment burden creates some difficult problems for our national economies.

To a certain extent, this implies a changed pattern of investment rather than a truly increased burden. The greater fuel bill for coal and oil in the absence of nuclear plants would have to be paid for by increased exports which, in their turn, would require bigger investments in our export industries. Greater coal and oil imports for conventional stations would also require new investments, notably in ships and ports for their transport.

At first, the expenditure on nuclear power stations will also pose balance of payments problems, because as much as 50 % of their cost may have to be paid in foreign exchange. But over the whole of the ten-year period the total import content of expenditure on nuclear plant is unlikely to exceed $ 1,100 million. Further if *all* the fuel for 15 million kW of nuclear plant had to be imported — a pessimistic assumption in view of the uranium production available within our countries — its cost would be about $ 2,000 million for inventory and make-up in the first ten years; and only about $ 200 million per year thereafter (ignoring plutonium credits), compared with an oil and coal bill to import fuel for the same plant capacity of about $ 800 million a year at present prices.

Therefore, though the balance of payments situation of our countries would not benefit immediately by the rapid introduction of nuclear power, the moderate increase in imports during the first years will be rapidly offset by big foreign currency savings subsequently. For these reasons, the expenditure of larger sums on building nuclear rather than conventional power stations is in the public interest.

However, this does not help our electricity suppliers to solve their investment problem; even now the rapid growth of electricity demand is putting a severe strain on the investment resources of our electricity industries. There is a gap between the public interest — which calls for the achievement of our target — and that of the individual electricity supplier, who faces commercial risks by investing heavily in nuclear rather than conventional stations. Yet a prompt commitment on the first plants is essential, both in order to get a quick start and to obtain the greatest experience of reactor construction in the shortest time.

As conditions differ widely in each of our countries, we are not in a position to suggest solutions. However, the Euratom Commission, jointly with the governments and industries concerned, should make a thorough study of this problem, for if it is not solved, it will make our target and the consequent stabilization of energy imports totally illusory. They should also consider incentives, such as increased depreciation allowances for nuclear stations, operative in the first and most difficult years, and other financial measures.

We also attach the greatest importance to a common legislative approach on insurance for nuclear plant, covering the third-party liability of companies engaged in constructing and operating reactors, as well as the liability of manufacturers outside our countries with respect to the performance of their products. In the United States, the absence of adequate Federal legislation may have seriously retarded the construction of reactors by private industry. Legislation to cover this gap is now being discussed by the U.S. Congress. All experts, both in the U.S. and the U.K., agree that the chance of accidents is exceedingly small. Nevertheless, additional protection against liability in excess of the available insurance coverage is necessary. If an accident should happen on the border of one of our countries, the damage might extend across frontiers. Big nuclear power stations might be ordered jointly by electricity companies in several of our countries. The common market for nuclear products, to be set up within a year of the establishment of Euratom, will also

facilitate the placing of orders across national borders. For all these reasons, a common legislative approach to these problems is necessary.

*
* *

Europe's economic growth is in danger of being seriously hampered by the lack of energy to nourish it. Being short of domestic energy supplies, our countries must turn increasingly to imports to meet their needs. But imports are costly; and in their most important form of Middle East oil, the supply itself is uncertain. To rely unduly upon them would be increasingly burdensome and hazardous. The advent of nuclear power now gives us a chance to stem their rising tide by building nuclear instead of new conventional power stations using imported oil or coal.

Comparison between the price of nuclear and conventional energy has lead us to conclude that a big effort now would be justified. Industrially, we believe this would be feasible, if our six countries act together, with the help of America, Britain and Canada, who are ahead of us in the application of nuclear techniques, and ready to cooperate fully with us.

The pooling of our financial resources, industrial capacities and varied skills through Euratom will enable our countries to muster the great effort required. Euratom will be able to guide and stimulate action, in particular by providing means to bridge the gap in the initial period between the commercial risk, which firms face in building nuclear plants, and the public need for the most rapid progress.

The establishment of the European Atomic Energy Authority, on which our nations are called to decide, offers the means to achieve the target we envisage: the construction of 15 million kW of nuclear plant by the end of 1967, in order to stabilize our imports early in the 1960's.