Louis Armand, Some Aspects of the European Energy Problem

Caption: In June 1955, the Organisation for European Economic Cooperation (OEEC) publishes a report drawn up under the Presidency of Louis Armand, Chairman of the Board of Directors of the French State Railways (SNCF), which focuses on the energy problem in Europe and considers the issues concerning the peaceful use of nuclear energy.

Source: Some aspects of the european energy problem - Suggestions for Collective Action, Report prepared for the O.E.E.C. by Mr. Louis Armand, Chairman of the Board of the Société Nationale des Chemins de Fer Français. Paris: Organisation for European Co-operation (OEEC), June 1955. 61 p. p. 7; 25-51.

URL:
http://www.cvce.eu/obj/louis_armand_some_aspects_of_the_european_energy_problem-en-6761172f-1f18-45b0-a247-e50faedb0e5d.html

Last updated: 05/11/2015

Some Aspects of the European Energy Problem

Suggestions for Collective Action

Report prepared for the O.E.E.C. by Mr. Louis Armand, Chairman of the Board of the Société Nationale des Chemins de Fer Français

Preface

On 14th December 1953, the Secretary-General of the O.E.E.C. submitted to the Council a memorandum drawing the attention of Member countries to the problem of the rising cost of fuel and power in Europe, the danger which this tendency might present for the development of the economy of Member countries and the ways and means which he considered appropriate for solving this problem, mainly by co-operation between Member countries.

At its meeting of 11th January 1954, the Council recognised the existence of an energy problem in Europe. As a conclusion to this first discussion, the Council considered that, before being able to decide what action might usefully be taken within the O.E.E.C., fuller information would be required as to the facts and specific proposals put forward with regard to procedure. The Secretary-General, instructed by the Council to report on these two points, considered that it would be desirable for the Organisation to have the opinion of someone highly qualified in these questions and therefore approached Mr. Louis Armand, Chairman of the Board of the "Société Nationale des Chemins de Fer Français". On 21st December 1954 he informed the Council that Mr. Armand was willing to place his services at the disposal of the Organisation.

The report prepared by Mr. Armand was submitted to the Council on 24th May 1955. After examining and deciding to publish the Report, the Council of Ministers agreed in principle, on the 10th June 1955, to set up a Commission for Energy and the Council, at one of its subsequent meetings, made further decisions as to its composition, terms of reference and methods of work. The relevant Resolution, which is reproduced *in extenso* in Appendix I, states that this commission, consisting of not more than 7 members chosen in a personal capacity, shall collect all useful information concerning the requirements and resources of Member countries in all forms of energy, examine problems of an economic and financial nature which may arise in this respect, compare the methods used to resolve them and formulate proposals for finding still better solutions by co-operation within the Organisation.

At the meeting of 10th June 1955, the Council of Ministers also decided to explore the possibilities of the economic and financial co-operation of O.E.E.C. countries in the peaceful use of nuclear energy and, for this purpose, instructed a Working Party to examine the possible scope, form and methods of such co-operation. The Resolution adopted to this effect is reproduced *in extenso* in Appendix II.

[…]

II. New Facts. Atomic Energy

Critical Stages in the Development of Energy Resources. Is Europe at a Turning-point?

The history of energy resources is marked by sudden changes, veritable revolutions that constitute important stages in the advance of civilisation; the most characteristic of these stages was the introduction of the steam engine in the nineteenth century followed, without any break in continuity, by the opening of the electrical and petroleum eras.

The use of electricity and oil, which must be regarded rather as an evolutionary than as a revolutionary development, has not affected the history of the various forms of energy as much as the advent of the steam engine.

It is at times when such trends make their first appearance, at such turning-points in economic history, that it

becomes necessary to survey the situation as a whole before deciding on a policy with a view to the future.

Europe must therefore take the necessary action and make its decisions in the light of past experience.

As the fuel and power supply of Europe is essentially based on coal it has not been in a position to derive as much benefit as other continents, more especially the United States of America, from the transformations resulting from the discovery of oil. While there is no need in this context to make a detailed analysis of this phenomenon, it can largely account for the lead taken by the American over the European economy. It is enough to recall that the part of crude oil for O.E.E.C. countries as a whole represents 16 per cent of total primary energy consumed against 38 per cent for the United States.

These figures will be referred to again later.

One of the first questions arising is whether the advent of atomic energy marks a turning-point similar to that of oil, and whether steps should not be taken now to ensure its rational development.

As for the more traditional European sources of energy, attention will also have to be given to the possibility of increasing resources of gaseous and liquid hydro-carbons, and the effect that these may have on the development of other sources of energy.

It is advisable to devote some thought to these matters as, until the memorandum was published, very little had been said on the subject and the eventuality of accelerated development has not been envisaged.

The memorandum has made a most timely appearance, as the urgency of the matter was recently confirmed by the publication of the United Kingdom White Paper on the 15th February 1955.

Atomic Energy

The large-scale use of nuclear fission for generating power was predicted as soon as the first pile or reactor was built 12 years ago.

A few words on the phenomenon of nuclear fission and reactor technique might be useful at this juncture to bring the problem into sharper relief.

Nuclear “fuel” is represented by three fissile materials, uranium 235, plutonium 239 and uranium 233. Uranium 235 is found in small proportions in natural uranium which contains one part U 235 to 140 parts U 238. Neither plutonium 239 nor uranium 233 exists in the natural state, but they can be produced in atomic piles or reactors, as will be explained later. When introduced under certain conditions in the reactor, these nuclear fuels split up and start a controllable chain reaction; the same reaction takes place in an atomic explosion but, in this case, it is uncontrollable.

The fission of the material is accompanied by an enormous release of recoverable heat and some reactors are designed in such a way as also to produce a fissile material from so-called “fertile” substances such as uranium 238 or thorium which are placed in contact with the nuclear fuel. The amount of fissile material thus produced can exceed the amount of nuclear fuel used (breeders). In others words, advantage can be taken of all the natural uranium and thorium, both of which mainly consist of inert isotopes; this can only be done progressively as and when it is possible to imprison these inert isotopes in reactors.

In less than two years, the advance of scientific knowledge has completely changed the fundamental data for the production of power from nuclear sources. It is reasonable to expect that still further progress from the present low yields may be achieved in the near future, not to mention the revolutionary development represented by the use of fusion (of the type used in the hydrogen bomb) if it is found possible to procure it otherwise than by having to use an atomic bomb or to convert nuclear energy into electrical power without first transforming it into heat. Note that the former hypothesis is regarded by Sir John Cockcroft as being

within the realm of possibility in a not too distant future.

After thus outlining the hopes for future scientific progress, some mention must be made of the means required to translate scientific knowledge into practical achievement. These are completely new technical problems calling for the invention of discovery or materials with properties the existence of which has been hitherto unsuspected, such as “transparence” to neutrons or resistance to a given flux of particles.

A completely typical case is afforded by zirconium, all the properties of which had to be studied in a few years. The advent of the atomic era has been very aptly likened to the discovery of fire; the comparison is particularly appropriate from the technical point of view, as mankind was able to master and perfect the use of fire as and when he learnt how to handle and shape the requisite materials.

It must also be remembered that it took 50 years of continuous technical progress for the internal combustion engine to emerge from its first theoretical stage to become the highly satisfactory power unit of to-day.

Possibly never in the history of technical development has any new departure given rise to so many new problems as the splitting of the atom, and this is going to call for a tremendous effort of technical research, on the success of which the speed of development of nuclear energy will depend.

Abundant Sources of Nuclear Energy. Position in European Countries

As is known, the sources of nuclear energy used at present are uranium and thorium, supplies of which are abundant; having regard to the much more thorough use made of them since the development of breeder reactors (see previous chapter), the quantities of potential energy represented by known or estimated reserves are very much higher than the known reserves of coal. It may be regarded as certain that, by the time the supplies of uranium and thorium are exhausted, other processes based on nuclear energy will have been discovered and a means found of using solar energy direct.

The following table gives some idea of known world reserves of nuclear energy compared with reserves of the more traditional forms:

Energy Resources of the World (not including wood and hydroelectric power)

The position in the various Member countries with regard to reserves of fissile materials is not clearly known but may be regarded as favourable on the whole; some Member countries, specially Belgium owing to its Overseas Territories, already produce sizeable amounts while others, e.g. France, have considerable resources either in metropolitan or in African territories.

This important point must not be overlooked. Whereas Europe made no great effort to exploit all its natural resources at the opening of the “oil era” it is fully conscious, at the opening of the “atomic era”, of its geological wealth.

The Price of Atomic Energy Already Regarded as Competitive

As atomic energy represents a great potential for scientific and technical progress, its price will certainly diminish. For the past few years it has been generally believed that the new form would in time become competitive, but few technicians thought that this would occur as rapidly as it is obviously doing today.

Particulars on this point are especially valuable in connection with this survey. To concentrate only on the essentials, reference may be made to the British White Paper of 15th February giving an account of a programme for the development of nuclear power stations during the next ten years; the programme is provisional only and will be modified in the light of any technical improvements that may supervene.

It is planned to devote £300 million to build twelve electrical power stations with a total capacity of

12,000 million kWh by 1965, i.e. the equivalent of 5 or 6 million tons of coal.

This plan is only a beginning and some United Kingdom writers have declared that, by 1975, no more coal-fired power stations will be built in the United Kingdom.

Similar information from American sources confirms the United Kingdom figures, and prominent personalities have stated that, by 1975, a substantial proportion of the power used in the United States will be generated in nuclear power stations.

Investment and Production Costs

The United Kingdom White Paper and various other publications, mainly by American authors, quote a few figures for investment and costs. As this in an industrial technique which is still in its infancy, these figures must be regarded as purely indicative. However, the element of uncertainty arises more with regard to how long the results must be awaited than to the possibility of their achievement.

Already it may be estimated that the cost per kWh should be approximately 0.6d, i.e. 7 millidollars (United Kingdom White Paper); this figure varies somewhat from the 7.5 announced by a group of Californian scientists (Isard and Whitney in 1946), or the 5 and 7.7 quoted for the Manhattan project in 1947, 6.5 to 7 by the Cowles Commission for Research in Economics, 5.8 by Stern, 8 by Gordon Dean in 1954, 8 by the Atomic Energy Commission in 1954 and 9 by the New York Consolidated Edison Company.

Some uncertainty admittedly exists as to the cost of nuclear fuel; only a few years ago, this was based on the value of plutonium when sold as a by-product for military purposes, but the tendency now is to base the value of plutonium on the assumption that it will be used entirely for pacific purposes, i.e. to consider it as an intermediary stage in a complete exploitation of uranium resources (see previous section on Atomic Energy). Nevertheless, the uncertainty is not so great as to cast doubt on the estimated costs based on the use of such materials purely as a source of energy; the advent of the “breeder” reactor may, however, change the situation completely.

The conclusion to be arrived at is that the cost per kWh of nuclear power will most probably be round about 7 millidollars during the next two years, diminishing thereafter as technique improves.

In actual fact, the figure of 0.6d./kWh is lower than the average cost of generating thermal power in the United Kingdom, but is not less than generating costs per kWh in an up-to-date power station fired by coal or fuel oil.

Probable Investment

The cost of building nuclear power stations ranges between $300 and $400 (depending on the scheme) per kW of installed capacity. Some recent projects in the United States mention the figure of $250 per kW. It is interesting to compare these figures with the cost of the traditional type of plant in O.E.E.C. Member countries ($180 per kW average for thermal and $270 per kW for hydro stations). Although the cost of nuclear plant would appear to be higher on the whole at the present time than that of traditional plant, there is every likelihood that it will settle down in the near future somewhere between the thermal and the hydro figure. On the other hand, nuclear fuel costs will range somewhere between 1.5 and 3.6 millidollars per kWh, i.e. much cheaper than fuel for the traditional type of thermal plant (an average of about 8 millidollars per kWh in Europe). It is really too soon, however, to attempt any detailed comparison taking into account running costs and depreciation for nuclear power stations.

The Cost of Atomic Energy Will Not Depend on Where it is Produced

On the economic plane, one of the more important features of atomic energy is that it enables power to be produced wherever it is wanted and at a cost independent of the precise locality, all other considerations being equal.

Thus the development of atomic energy may profoundly alter economic geography because hitherto, to ensure power supplies, it has been necessary to concentrate large industrial concerns around particular natural sites: coalfields, large-scale hydro schemes, etc.

In future things may be quite different. The power will be produced where needed at practically no additional cost because, contrary to what happens for other forms of energy, the cost of transporting fissile materials will be negligible.

There is no need to go in great detail into the economic revolution which may ensue, especially in countries which are under-developed owing to the lack of power supplies. In these countries power is comparatively dear and nuclear energy would be competitive from the very start. It is paradoxical that the only countries capable of making the plant required are those which became highly industrialised because the traditional sources of energy were abundant. This must be put forward as yet another argument in favour of useful co-operation between the rich and the under-developed countries, e.g. Europe and Africa. The latter continent can always endow Europe with wealth in the shape of uranium ore.

The United States is planning large-scale development for atomic energy in the hope that power can be produced at prices competitive with that produced from traditional sources, although the latter is already distinctly cheaper than in Europe. There is no reason why Europe and the United States should not have atomic energy at the same price.

It will therefore be seen that atomic energy offers an even greater opportunity for Europe than for the United States. The United Kingdom decision is therefore timely and, in short, should precipitate a decision in the matter by other European countries.

At this juncture, a paragraph must be quoted from the United Kingdom White Paper as it will answer a number of objections in advance in an admirable spirit of confidence in the future (para. 52 of the White Paper):

“New technical developments that cannot at present be foreseen may perhaps lead to a more rapid improvement in the performance of stations than has been assumed. If so, we should be in a good position to take advantage of such developments. On the other hand the provisional programme may turn out to be too optimistic. The stations may take longer to design and to build; they may cost more and the amount of development work needed may have been underestimated. If any of these things happened, nuclear power would come later or be more expensive than the programme suggests. Her Majesty’s Government consider that these risks must be accepted.”

Action Proposed at O.E.E.C. Level

There is a very clear case for international co-operation between Member countries of the O.E.E.C.

Co-operation could take three forms:

1. Exchange of scientific knowledge;
2. Supply of fissile materials;
3. Exchange of technical information and joint construction and financing of plant.

The recent setting up of the European Organisation for Nuclear Research, the European Society for Atomic Energy, or the immediately impending International Agency for Atomic Energy, would seem to meet the

case for the first two points. O.E.E.C. could keep in touch with any developments in those activities.

With regard to the third activity, however, it is felt that the presence in O.E.E.C. of countries which are well ahead with nuclear schemes, e.g. the United Kingdom, taken in conjunction with the latter's suggestion regarding co-operation with other countries in this matter should enable O.E.E.C. to look forward to close co-operation between the various Member countries in the task to be accomplished during the next few years.

Incidentally, this is an essential pre-requisite for the success of Europe in nuclear power, as many Member countries do not seem to dispose of the means required for carrying out a nuclear programme and there are a great many technical problems the solution of which will call for a co-ordinated effort backed by the mobilised industrial potential of all Member countries. Only in this way will possibilities in Europe bear comparison with those in the United States.

If this were done, Europe's prospects in nuclear energy would be as favourable as those of the United States, as all other conditions are substantially the same on both continents.

It is therefore considered imperative that O.E.E.C. should take the lead in action towards achieving the closest possible association between the various governmental or non-governmental organisations competent to deal with atomic energy (the fact that some of these organisations are governmental seems to suggest that action by O.E.E.C. is essential).

It should be noted that the necessity for association has been grasped in the United States where, despite the competitive spirit which so happily prevails between a number of industrial groups sufficiently powerful to act in isolation, a movement has started at the instigation of Mr. Walker Cisler of the Detroit Edison Company for pooling the financial and technical resources of 33 companies.

The formation of a similar group in Europe would call for international action. It may therefore be concluded that, if the countries of Europe wish to adopt a policy with regard to atomic energy which will rapidly lead to satisfactory production costs, a solution at European level would be infinitely preferable to one on a strictly national plane.

Consequence of the Advent of the Atomic Energy on General Power Policy

The first consequence of the dawn of the atomic era must be to abolish the fear of any power shortage in the future; it will therefore be necessary to abandon the idea that power costs in Europe are linked irretrievably with the price of coal and are therefore bound to rise, as the future cost of atomic energy will certainly be lower than the average prices charged in Europe at present.

This is a basic observation and although, for many years to come, atomic energy can hardly account for more than a small proportion of the total power supplies, it must already be taken into account in determining future power policy.

However rapidly it may develop, atomic energy cannot alone cover the anticipated increase in demand during the next ten years or so. There are many reasons for this, the principal being that natural uranium and thorium become more potent sources of energy the more they are worked (see previous section on Atomic Energy) with the result that development will be slow at first, but will subsequently be speeded up considerably. The speeding up will probably not be faster than foreseen by the United Kingdom where it is considered that by 1965 a quarter of the new requirements in electrical power could be met from atomic power stations and all increase in demand by 1970 or 1975.

In any case, all estimates agree that a certain proportion of the increased demand for power will have to be met from traditional resources in the next 10 or 20 years. In the immediate future, therefore, there will be no need for any profound change in equipment plans; nevertheless, investment policy will have to be diverted towards a future very different from what was anticipated a few years ago. Instead of "more and more

power", the slogan will now have to be "cheap power above all".

It would be prudent to make the inevitable revision of programmes at international level, as the possibility of mutual assistance will now appear in a new light. With regard to European plans for new capital equipment, it must be remembered that it would be particularly advantageous to promote co-operation right at the outset of the atomic era, as it is always easier to co-operate in the new rather than the old.

III. Present and Future Aspects of Certain Questions Relating to Traditional Sources of Energy

The Council of the O.E.E.C. has been kept informed by the reports of its Vertical Committees of the problems arising in all power sectors, and it has been considered unnecessary to recapitulate here the extremely valuable studies completed by these committees, which have been read by the author of this paper with the greatest interest.

An apology is therefore due for referring here only to one or two particular features of certain important matters coming within the competence of the Vertical Committees.

Crude Oil and Natural Gas

The most outstanding feature of Europe's situation with regard to oil is undoubtedly the fact that most supplies have to be imported, as will be seen from paragraph 32 of the Oil Committee's Interim Report (October 1954) on Developments in Oil Refining and Consumption Trends. About 77 million tons of crudes were imported in 1955, i.e. 97 per cent of total consumption, representing a heavy drain on foreign exchange, a substantial proportion being in hard currency (dollars).

Undoubtedly the recent and successful prospecting in some parts of Europe, especially in Italy or France, holds out the hope of large reserves of crude oil and natural gas in Europe.

Large areas of Africa are also being prospected, especially the French territories of the Sahara and Cyrenaica, and first results suggest that substantial deposits of oil-bearing strata may be discovered.

There is therefore a possibility that a rapid extension of these efforts may lead to a considerable improvement during the next ten years or so in the power position of Member countries.

In the case of Africa, the potential reward and the scale on which the work would be undertaken is so great that European co-operation would seem particularly desirable. It would speed up work and mobilise capital and technicians for the purpose of finding new reserves of oil, thus avoiding the drain on hard currency experienced by European countries. This, too, is an entirely new sphere of activity in which it would be advisable to set up European associations without delay.

The question of natural gas is also of the greatest importance to Europe.

The discovery of the deposits in Lombardy which have proved such an asset in the Italian economy and the forthcoming development of the reserves found at Lacq in Southern France afford two examples.

Natural gas is a particularly valuable form of energy because costs are low and, also, it is a polyvalent fuel, i.e. it will very efficiently and easily supply heat, drive machinery, or provide raw materials for a number of chemical industries producing nitrogenous fertilizer, plastic materials and so forth.

It is a well-known fact that the United States has enormous reserves of natural gas which constitute a cheap source of energy. In 1951 the United States of America consumed only 15,000 million cu.m. of manufactured gas as against 210,000 million cu.m. of natural gas (compared to 2,700 million in O.E.E.C. countries in 1953).

The Economic Aspect of Natural Gas

There are two different ways or looking at the potential economic role of natural gas.

First, it may be used to feed distribution networks supplying town gas; in other words, it can be classified as “non-productive” power. In this case, investment mainly centres on distribution, and the effect on costs is likely to be comparatively slight: above all, as this is a case of “non-productive” power, there is every likelihood that its effect on the general economy will be insignificant.

On the other hand, natural gas may be regarded as a living source of “productive” power, which will then be reserved for creating new industries likely to consume substantial quantities of a form of energy which is singularly convenient to use (e.g. heating of metallurgical furnaces).

In such cases, the whole economy of certain regions may genuinely be given new life by the discovery of natural gas. Should the life of deposits appear likely to be limited, e.g. to a period of 20 years, it might be advantageous from the general economic standpoint to set up an industry and work the deposit intensively for such a period rather than extend its exploitation by feeding it at a slower rate to a town-gas network.

Natural gas should be regarded rather as an industrial than a town gas.

In Europe, gas has always been used preferably for domestic purposes or in small-scale industry, whereas in the United States of America 56 per cent of natural gas output is accounted for by industry, 31 per cent by domestic consumption, the remaining 13 per cent being used for miscellaneous purposes. Only Belgium and Germany show a preponderance of manufactured gas in industrial consumption; in Germany, the bold policy adopted by the “Ruhrgas” has led to linking up the output from coking plant and blast furnaces to the natural gas network.

Prospecting for Natural Gas

The importance of prospecting for oil and natural gas in Europe has already been mentioned, but it might also be desirable to draw on other sources outside Europe.

It has been suggested, for instance, that a pipeline should be laid for bringing to Western Europe the gas at present unused in the oilfields of the Middle East; an American firm, the Bechtel International Corporation, has evolved a bold project which would bring gas from Iraq to about fifteen European countries accounting for a population of over 300 millions; the pipeline could handle each year a volume of gas with an energy equivalent to 6.5 million tons of coal; the cost of transport, estimated at Frs. 3.10 per cu.m. compares favourably with gas production costs in France (roughly Frs. 12 per cu.m.). A transmission line 4,000 km long (not counting branch lines) presents no insuperable technical difficulty as this has already been done over comparable distances in America (3,100 km Texas–New York; 3,600 km from Alberta to Toronto and Winnipeg).

The principal difficulty would probably be political as the pipeline would have to pass through several countries and inter-governmental negotiations would be required to guarantee supplies of the gas over long periods (20 years) at very cheap rates, otherwise the project would present no interest.

As most of the political implications mentioned above are outside its province, O.E.E.C. would not be able to take any action before preparatory work had been done to render conditions favourable.

Incidentally, a pipeline would not be the only way to bring gas from the Middle East. Studies have already been made on transporting gas liquified at low temperatures on shipping specially equipped for this purpose.

This process, which has been evolved in the United States by Mr. W. L. Morrison, will be tried out for the transport of liquified gas by barge from Texas to Chicago. F.O.A. has instructed the “Conseil National de la Recherche” and the “Académie Nationale des Sciences” to report on the possible uses of gas from Saudi-

Arabia; in drawing comparisons between transport of liquified gas by pipeline or by sea, this report has provided a lot of information on Mr. Morrison's process. The transport of the equivalent of 5.5 million tons of coal to Western Europe would call for 20 specially designed tankers (capacity 15,000 tons). First estimates have shown that costs would be slightly higher than transport by pipeline, but still definitely below the present cost of manufactured gas in Western Europe.

Such a technique would enable a start to be made on a small scale, it would avoid some of the extremely complicated political problems created by a pipeline and would not necessarily restrict supplies to the Middle East; for instance, the same shipping could subsequently be used for carrying natural gas from Africa if the prospecting now being carried out there fulfils all that is expected of it. There would also be no difficulty in finding new uses (after conversion) for shipping, particularly colliers, which would not otherwise be easily adapted.

A number of wealthy countries might take an interest in such a study which, like the pipeline project, would probably engage the attention of the O.E.E.C.

Manufactured Gas

This section may aptly open with a few remarks on results achieved in Germany. Germany has long pursued with success a policy for the very intensive use of coal gas. For instance, "Ruhrgas" has undeniably succeeded in building up a genuine industrial complex covering a large number of industries over a very extensive geographical area including the Ruhr and extending to Brunswick, Mannheim and the Saar frontier.

The distribution network covers a total of 2,300 km of mains with an average daily flow of up to 11 million cu.m. The gas is produced either by coking plant, which fluctuate in activity according to the needs of the iron and steel industry, or by gasworks the output of which is adjusted to provide a regular intake into the network. All these works are being constantly improved and those which are now in the van of technical progress are equipped with high capacity integral gasification units and with every possible device for regulating gas flow with extreme accuracy. It will be noted that other up-to-date techniques including continuous coal distillation, now in the course of being perfected, will help to improve the overall yield still further.

A policy of this type, like coal gas, gives rise to several specific difficulties, two examples of which may be cited: a) it becomes technically necessary to lay out large-scale structures in order to minimise the lack of balance between production and demand at a given period; b) from the economic point of view, it calls for consideration of production cost of the various products involved in a given operation, e.g. distillation where it is impossible to consider the price of gas separately from the price of coke. In considering the more promising continuous distillation processes, e.g. pre-distillation of hard coal, it is presumed that the coal after de-gasification is immediately burned in a thermal power station. This provides another example of the ever-closer inter-dependence existing between various industrial activities which is particularly evident in all matters relating to coal.

The German Delegation to the O.E.E.C. submitted a memorandum (14th December 1953) on gas as a source of energy, paragraph 12 of which clearly describes the dependence of gas economy on outside factors. Paragraph 14 of the same paper presents solutions for remedying the situation.

It concluded by suggesting that it would be advisable, within the context of O.E.E.C., to carry out:

1. A special study on gas with special reference to a more efficient use of coal;
2. A more general study to define the broad outline of a policy which would provide all the energy required for the development of the economy but drawn as far as possible from sources available in Member countries, and which would ensure that these sources were used more rationally than in the past.

It will be for O.E.E.C. to decide what action should be taken on the German memorandum, which has already received some attention. In response to a request by the Secretariat that this memorandum should be referred to in this Report, it should be sufficient to emphasise how right it is that the question of coal-gas should be considered in conjunction with the problems confronting other sources of energy. The author wholeheartedly agrees with the following observations:

"In a modern economy a great variety of relationships exist between the coal-gas industry and the coal, electricity, iron and steel, oil and chemical sectors. In certain sectors, gas can be substituted for coal, electricity or oil, or may even itself be a raw material. It is therefore essential to study the basic economic facts so as to avoid the possibility of losing any of the advantages accruing from a continuous expansion of the gas industry. Such a study should be undertaken by specialists on gas questions in order to observe the principles of the O.E.E.C.'s policy that all economic sectors should have an opportunity to defend their interests within the O.E.E.C. Of course, a general study of this kind must also take the general interest of the community into account."

To sum up with a metaphor, it may be said that coal-gas represents, as it were, a cross-roads in the realm of energy and this industry is less suited than any other for an isolated study, as all its problems are dominated by matters of much more general scope. It would probably be inadvisable, therefore, to set up a Vertical Committee for Gas.

On the other hand, the same considerations constitute powerful arguments for including representatives of the gas industry in any body responsible for general studies dealing with energy. It would also be extremely desirable for some countries to carry out a joint study of the application of various techniques for the integral gasification of coal.

Joint studies should also be undertaken by the coal-gas and natural gas industries; both have many points in common in respect of which it might be an excellent thing to be able to draw on wide experience, e.g. in the use, transport and storage of gas. Separate mention may be made of underground storage which is now being studied by both France and Germany and which, following the American example, might well prove the starting point for far-reaching developments.

Part of these joint tasks might be entrusted to non-governmental organisations such as the "Comité d'Études Économiques", an unofficial body representing gas producing industries in several Member countries, and the International Gas Union (headquarters Brussels) which deals principally with the technical aspect of the industry.

New contacts might be organised by O.E.E.C. especially on all matters in which gas is associated with problems in other power sectors (this also appears from the German memorandum).

E.C.S.C. might also study certain economic problems linking gas with coal and even with steel; these questions are all associated, as a policy aimed at lowering steel prices might, for instance, lead to lowering the price of coke, at the same time trying to increase the price of by-products, e.g. gas, as much as possible; this would naturally lead to a general increase in the price of energy.

Electricity

The production of electricity is a familiar subject and the many studies made provide evidence of the effort to lower electricity costs.

In the case of thermal power:

Production mainly depends on the output of coal (this accounts for about 50 per cent cost). This explains why the cost of generating thermal power is generally higher in Europe than in the United States; and the future holds out but little hope of any improvement in this direction.

As is known, considerable progress has been made in recent decades towards reducing coal consumption per kWh in thermal power stations. As against 6,000 to 8,000 kcal in 1920, specific consumption in Member countries averaged out at 4,300 kcal in 1952; more recent installations in Europe show a specific consumption of 3,000 kcal per kWh whereas plant recently installed in the United States has now reduced the figure to 2,120 kcal per kWh.

Technical progress has, however, always been partly offset by the rising price of coal and the cost of equipment; nevertheless, there has been a steady decline in the overall cost though the cost per kWh has not fallen as much as might have been expected from improved efficiency.

The question of thermal power is in fact bound up with coal policy as, although it is now easy to burn low-grade products in power stations, these fuels tend to become more expensive as increasing uses are found for them; in short, the mining companies endeavour to make as much as they can on low-grade fuels to avoid having to put up the price of the better qualities which have to face competition from oil products. This particular problem will assume a different aspect as and when the tonnage of low-grade products rises in proportion to total coal output as a result of progressive mechanisation in the pits.

This provides further evidence of the deep-rooted inter-relationship of problems which will have to be solved at a level going beyond the technical competence of Vertical Committees.

Similarly, competition with fuel oil may fail to have the favourable effects which might, at first sight, have been expected on the price per kWh of thermal power, as fuel oil for power stations is often priced in terms of calories of coal. Nevertheless, apart from any effect produced by national taxation or price equalisation systems, the price of oil products depends on world developments in the oil industry and must therefore be considered in a wider context.

These various points do not call for further comment here as they have already been thoroughly dealt with; it will suffice to note that “coal” is a factor making for complexity and inertia in power costs, especially for industrial purposes, in Europe. It will be necessary to react against this tendency if the European economy is to extract the maximum benefit from the new sources of energy.

It is nevertheless felt that technical progress should enable thermal power stations during the coming years to supply power at distinctly cheaper rates per kWh than at present.

Assuming that in 15 years’ time any new capital equipment programme would solely be concerned with atomic power stations, this would not mean a complete break in continuity so far as the design of power stations is concerned, as coal burning and nuclear fission equipment have many features in common.

With regard to hydroelectric power, production costs vary widely, depending on location of the station and the manner in which the head of water has been harnessed, i.e. run-of-river plant, storage plant, etc.

There are no grounds for supposing that much further progress can be made with the mechanical part of hydroelectric plant. Economy in civil engineering work could alone lead to lower capital outlay per kW, which nevertheless continues to rise as a whole (as will be seen from Table 13 of the Electricity Committee’s last report).

It appears probable therefore that some of the hydroelectric schemes will have to be revised in the light of nuclear power developments. It should be borne in mind that atomic energy will mainly be used to carry a basic load, whereas hydro-storage plant is especially indicated for peak supply, i.e. “high quality” power.

Above all, the principle underlying future programmes will have to be to produce power as cheaply as possible and uneconomic schemes will have to be abandoned.

In future, costing will no longer have to be based on “European coal price indices” if the aim is to achieve a genuine decrease in the price of energy. Clearly, however, it must not be forgotten that an electrical plant programme forms a balanced whole in terms of the structure of demand and general production conditions.

On the other hand, conditions are very different for certain sites in Europe regarded as sources of cheap hydroelectric power (paragraph 7 of the memorandum). Their productive capacity is considerable but they are situated far from the centres of consumption. This is true of the harnessing of waterfalls in Northern and Western Scandinavia, Yugoslavia and Austria.

In 1950, annual output from hydro resources which could be exploited at a profit was estimated as follows:

Estimated Annual Output from Hydro Resources (1950)

It is to be hoped that most of these new schemes will have low production costs (in Norway, for example, plant costs $133 per kW in 1953 as against $268 on the average for other Member countries) in which case they would represent a firm asset to European economy. Long distance transmission is, however, out of the question, and what is needed is the transfer of industry capable of using large amounts of electricity on the spot: aluminium, electro-metallurgy, electro-chemical industries.

It might be possible for a broad measure of co-operation to be established between Member countries for a twofold purpose:

First, a general study of favourable sites, classified independently, of national territories and solely on costs;

Secondly, a review of the industries that might be set up near such sites. It is not impossible to imagine customs facilities similar to those granted to free ports in respect of deliveries of raw materials and the despatch of finished products. Genuine concessions would then be granted in the “European industrial zones” thus constituted, to which countries where power is dear could transfer some of their industries.

The O.E.E.C. might well consider the economic possibilities of such an arrangement for the benefit of the European economy as a whole.

Other zones of the same type might be set up around the enormous sources of water power in certain African territories, which represent a considerable proportion of the world’s potential in energy of this kind.

In the French African territories, for instance, the Konkouré (Guinea) and the Kouilou (Middle Congo) schemes have a total production capacity of about 12,000 million kWh at a cost of something like one French franc.

Such sites may compare with those recently opened up by Canada and are certainly not less accessible; the development of these sites might, within a very few years, bring Europe substantial additional supplies of cheap power which would enable certain industries to expand and become competitive on world markets.

As in the case of natural gas, cheap water power represents a hitherto unexploited source of energy which, if rapidly harnessed, could serve like an inhalation of oxygen to stimulate some sections of European industry.

Coal

This report will not deal at any length with coal problems which, because of the important part played by coal in Europe’s economy (coal represents 80 per cent of Member countries’ total gross consumption of energy), have been thoroughly investigated by numerous governmental, international or supra-national

organisations (Coal Committees of the O.E.E.C., the E.C.E., the E.C.S.C. etc.).

It is a well-known fact that European coal prices are a serious handicap. A case in point is provided by the May 1953 pithead prices given in paragraph 2 of the memorandum: $6.5 a ton for coking fines in the United States as compared with $12 and $14 in Germany, France, Belgium and the Netherlands and $11 in the United Kingdom.

It is felt, however, that it would be advisable to review coal mining policy in the light of new possibilities for the supply of cheap power. Such a study would undoubtedly be more profitable if conducted at international rather than national level.

As already stated, the mining companies' traditional policy has been hitherto dominated by the determination to exploit deposits rationally with a view to the maximum possible output while at the same time nursing the reserves. It seems as if the moment may now have come to adopt an "extensive" policy under which some degree of waste would be acceptable provided costs were kept down. A policy of "taking off the cream" has been mentioned but, as already stated, this is purely a matter for future policy and no immediate difficulties are involved. Nevertheless, the next few years ought to be devoted to paving the way for a development which appears to be inevitable.

There can be no immediate prospect of a reduction in coal requirements which are, on the contrary, likely to increase. The iron and steel, gas and chemical industries will certainly have to increase their coal requirements, and all experts engaged in forecasting the future as far as coal is concerned are agreed that this is inevitable. Paragraphs 45–47 of the British White Paper also mention the probability of high coal consumption in Great Britain, despite the launching of a large-scale nuclear programme.

Nor should it be forgotten that new equipment will have an important bearing on prices. In these circumstances, the modernisation plans for certain mines will remain just as necessary for many years to come.

Brown Coal

It is from this angle that the problem of German lignite, from which electricity can be generated at remarkably low cost per kWh, should also be approached. Development seems to have been held back so far by the fear of running down too rapidly the comparatively small reserves. The question arises as to whether, on the contrary, it would not be more profitable to work out this source of cheap energy in the short-term, e.g. perhaps the next five or ten years.

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No mention has been made of technical developments which, as stated in the memorandum, might lead to substantial progress or even far-reaching changes (e.g. underground gasification, in spite of the disappointing results of some of the trials conducted so far, though on a small scale). In this connection there is considerable unused potential in the European coal and gas industries which, based on lower prices, should be put to maximum use during the next few years until such time as atomic power is in a position to play a more important part.

Conclusions

By way of conclusion, an attempt will be made to answer the various questions raised in the memorandum from the general considerations set out in this report.

I. Fuel and Power Economics Committee

To an increasing extent the more complex problems relating to fuel and power are becoming economic rather than technical, i.e. each one should be approached in such a way as to form part of a broad synthetic view of general developments throughout the energy sector.

Needless to say, the Vertical Committees will remain fully competent to deal with questions depending primarily on factors of quantity and production. But this no longer applies when the factor of competition comes into play and the dominant need is for comparative costings of the various forms of energy from the standpoint of production and consumption.

If broader economic views are to prevail, O.E.E.C. must concentrate its efforts on this point. A Fuel and Power Economics Committee should be set up composed of a number of members particularly qualified to deal with matters relating to energy; it would be for this Committee to determine, at the highest level, the principles on which future policy should be based. Such a function should certainly be performed by an international institution of this kind as it would be in a better position than other bodies to define guiding principles in more general and therefore more independent terms. National or international bodies concerned would most certainly derive great benefit from such an institution which would be in a position to place a whole mass of economic knowledge at their disposal.

Experience in the transport sectors has shown that failure to define in good time the guiding ideas on which sound co-ordination must depend might well create a very difficult situation with disastrous effects for the community as a whole.

The experience of transport seems to show that it is unlikely that a body competent to deal with matters relating to power economics will automatically come into being. Such a body will only materialize if the governments take the initiative; except for the World Power Conference, a completely new departure in this direction, the only incentive to set up international unions has hitherto been the grouping of interests in connection with specialised energy sectors.

Consequently, the Council of the O.E.E.C. should consider setting up a Fuel and Power Economics Committee.

Such a committee should have a fairly restricted membership so as not to detract from its efficiency. Its aims would be:

a) To keep abreast of economic developments;
b) To promote ideas with a view to avoiding a situation in which competition between the various forms of energy acts to the detriment of the community as a whole;
c) To disseminate sound ideas in political and economic circles and to educate public opinion;
d) To do away with the twofold classification of power problems into separate compartments, by country and by form of energy, and to encourage the spirit of co-operation;
e) To place in the hands of appropriate Working Parties any specific problems, particularly investment priorities, that might arise between two or more countries or forms of energy when these problems go beyond the scope of the Vertical Committees.

II. European Studies on Gas

Obviously, it might be possible to set up a Vertical Committee for Gas but, having regard to the direction likely to be taken by problems of the future and the existence of non-governmental organisations such as the “Comité d’Études Économiques” and the International Gas Union, it would probably suffice to have representatives qualified to deal with gas matters attached to the Fuel and Power Economics Committee.

Such a representation is essential in view of the importance of this form of energy, and the value that the experience of large organisations like the “Ruhrgas” might have for all Member countries.

Moreover, such a committee would be able to derive benefit from studies on gas carried out by other bodies such as E.C.S.C. and to set up Working Parties as required to deal with matters solely concerned with gas: links between coal gas and natural gas systems, transport of gas, etc.

III. Natural Gas

The value to European countries of natural gas as a high-grade form of energy has already been pointed out. Prospecting will therefore have to be carried out on a wider scale and the proposition studied for transporting natural gas from the Middle East to Western Europe. The occasion would be particularly suitable to consider the possibility of drawing on any reserves of natural gas that might be found in Africa. The necessary studies could be entrusted to a group of experts working under the direction of the Fuel and Power Economics Committee.

IV. Nuclear Energy

Nuclear energy gives Europe the possibility of having an abundant supply of power at steadily decreasing cost in 15 or 20 years’ time.

Europe could be in just as favourable a position as the United States as regards the cost of atomic energy if the various countries of Europe combine to supply the raw materials (fissile materials or special metals) and pool their technical potential in the many sectors related to the new technique (manufacturing and processing of new materials, technology of reactors and the corresponding chemical processes).

In view of the importance of the whole subject and the considerable scientific, technical and financial effort required to find solutions, intra-European co-operation is certainly more vital in connection with atomic energy than in any other field.

The recent setting up of bodies such as the European Organisation for Nuclear Energy, the European Atomic Energy Society and the creation in the near future of the International Atomic Energy Agency are the first steps towards co-operation in the exchange of scientific knowledge and the supply of fissile materials. This kind of co-operation must be encouraged in every field, particularly as regards the exchange of technical information and the joint construction and financing of nuclear plant on an industrial scale.

If the Organisation took advantage of the generous offer of the United Kingdom Government, it might play a fundamental part in this co-operation which might assume widely different forms: inter-governmental agreements, formation of groups of industrialists from various countries, etc.

If the idea were adopted, no time should be lost in setting up a study group for industrial nuclear energy within the Organisation.

V. Electrical Power

The value to Europe of new sources of very cheap hydro power, which could be harnessed in Europe (Norway, Yugoslavia, Austria) and in Africa, has already been emphasised. The power thus generated could be used to supply heavy consumer industries such as the aluminium, electro-metallurgy or electro-chemical industries. As electrical power cannot be transported economically over long distances, these industries would have to be set up near the source and it seems reasonable to expect that, provided the necessary customs arrangements were concluded, genuinely international industrial zones might thus be created.

If this principle were adopted, the Electricity Committee seems to be in a good position to undertake useful work in determining the more favourable sites for hydroelectric development. It must be decided whether the complex problems arising from the creation of international industrial zones will not necessitate the creation of a special Working Party under the aegis of the Fuel and Power Economics Committee.

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These are the directives which seem likely to give a new impetus to the work of international co-operation that has already been begun in connection with energy.

By taking into account new facts and by discarding certain obsolete ideas, it is hoped that this report has shown the need for restating the case with regard to energy in terms of general economics in order that the maximum benefit may be derived from technical progress with a view to improving the lot of each individual inhabitant of a still more united Europe.