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Tel. 7350040 (Ext. 5120 and 3843)
Telex 21877 COMEU B

Development

SOLAR ENERGY: A NEW AREA OF ACP–EEC COOPERATION

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SOLAR ENERGY: A NEW AREA OF ACP-EEC COOPERATION

Solar — the very words capture the imagination. But if we combine the mystical regard in which centuries of civilization have held the sun with the ecologists' dream — the production of clean energy — the utopian vision of boundless energy production will surely have become reality.

Things are not as simple as that, however. Attractive as it may be, solar energy is not yet an alternative capable of replacing fossil fuels as an energy source. Applied research into solar energy was begun only very recently. Indeed, as long as oil was flowing freely and cheaply, what reason was there for spending large sums on costly research in an apparently uneconomic field?

The decision taken by the Organization of Petroleum Exporting Countries (OPEC) in 1973, which led to a quadrupling of oil prices within the space of a few months, provided, as could be expected, most of the countries which had the means to do so with the necessary stimulus to develop new ways of producing energy from what are referred to as 'new energy sources'.

Solar energy occupies a special place among these new energy sources for the following three reasons:

(i) With the exception of geothermal energy, which, by its nature, is geographically of very limited application, solar energy at present represents the sum total of the possibilities actually available as regards alternative energy sources.

(ii) At the present stage of technological progress, solar energy can only go a small way towards satisfying world energy requirements. However, while it is expected to account for 2% by the year 2000 in the industrialized countries, its contribution will be 4% in the case of the developing countries, where climatic conditions and the decentralized social structures provide an ideal location.

(iii) Solar energy is particularly suited to use in a rural environment. In view of the efforts being made to avert a world food crisis, mainly in Third World countries, no new technology which might bring about an improvement in rural living conditions and an increase in agricultural productivity can be ignored.

This is not crystal-ball gazing. Right now, African, Asian and Latin-American peasants, for whom the cost of fuel oil has become prohibitive and whose consumption of wood raises the danger of deforestation, are benefiting from the use of low-output solar installations. However, there are very few such installations at present.

In presenting the problem in this way, an important variable has been left out of account: the cost of solar installations. Whether we are talking about small irrigation pumps, multipurpose solar-powered engines, cooling or telecommunications installations, solar equipment is still, in general, very costly. In a market economy, only a sufficient increase in the consumption of a product can bring about a reduction in its unit price.

Moreover, as with any technological innovation, the choice of solar energy involves training the users and indeed developing research into better means of adapting it to local requirements. All these are prohibitive factors for countries which, being the poorest, having no energy sources of their own and having problems of access, have the most urgent needs.

In the circumstances, the role that has to be played by international aid is clear. The provision of direct financial aid to pay for equipment or technical assistance in training and research in the solar energy field is not inspired by philanthropic sentiments but is a necessary contribution to the creation of a new world energy order.

The European Community, which is dependent for more than half of its energy supplies on outside sources (prior to the coming on-stream of the North Sea fields) has every reason to want to be at the forefront of a movement of this kind.

As the Community is the world's leading trading power, its industries are also likely to profit by exporting new and advanced technological products.

If only to be faithful to its progressive image in the field of cooperation with the Third World the Community must move in this new direction.

This is already being done. The political decision which is bound to extend this movement was taken by the Heads of State or Government of the nine Member States in July 1978 in Bremen. Ten days later it was confirmed in Bonn at the Western Economic Summit.

This decision, falling as it did within a few days of the official opening of the negotiations for the renewal of the Lomé Convention, will no doubt make it possible to establish more formal cooperation with the African, Caribbean and Pacific (ACP) States in this field. This will be all the easier since the way has already been prepared within the framework of the existing Convention.

COOPERATION ON ENERGY PROBLEMS BETWEEN EUROPE AND THE THIRD WORLD: A CRUCIAL CHALLENGE

The consideration given to world energy problems has never been so intense nor the desire for cooperation so frankly expressed as since 1973. The threat of a shortage leaves no alternative!

The position at the beginning of 1979 is bleak: the moderation recently exercised by the OPEC countries has done nothing to restore the industrialized countries' former optimism; nor for that matter has the discovery of large oil reserves in Mexico. The West's consumption is increasing annually by 80 million tonnes, which means that, at best, foreseeable Mexican output of 400 million tonnes would only make it possible to postpone the oil crisis for five years.

What about nuclear energy? 'No, thanks!' replied the Austrian voters in November 1978 when asked their opinion on this form of energy. In the United States, ecologists have recently lost six referendums on nuclear energy, but France and Japan, the only countries to commission new nuclear power stations in 1978, were only able to do so at the cost of increased social tensions.

Coal, of which there are reserves for hundreds of years, is coming up against environmental problems just about everywhere, and energy conservation is thwarted by the inertia of consumers and governments.

And yet, one would have to be very naive to count on a stabilization of oil prices. It has become a truism, which is nevertheless still worth repeating, to say that the 1973-74 price hike had disastrous effects on the economies of the industrialized countries, on the international balance of payments situation, compounding an already serious level of inflation, and, last but not least, on the non oil-producing developing countries, whose growth prospects were stunted.

Facts and figures: A serious situation

World energy outlook

The energy consumption of the world's present population of 4 000 million amounts to approximately 6 300 million tonnes oil equivalent (toe).

By the end of the century, 6 500 million people, nearly 4 000 million of whom will be living in the developing countries, will be consuming 17 000 million toe.

The North-South energy imbalance

At present, 30% of the world's population consumes 83% of its energy. By the year 2000, the corresponding figures will be 22% and 70%. Inequality of the same order is typical of the distribution of energy resources among nations. Such a situation, if it persisted, would condemn many countries to an irremediable and intolerable level of underdevelopment.

Means of redressing the balance

In a period of abundance, adjustment policies could be devised to mitigate the effects of these inequalities, or even go some way towards reducing them, but in the present period of impending shortage, the only permanent way of eliminating this handicap in the least-favoured countries is to give them the means to develop local energy resources which would at least satisfy their own requirements.

Some of the practical proposals put forward by the World Bank and the European Commission are as follows:

(i) The development of oil prospecting: according to the World Bank (World Development Report), between 30 and 40 developing countries would be able to produce oil in varying quantities if they had the necessary technology and financial resources to develop their potential.

(ii) The coal, even of low grade, that is available in many developing countries, might profitably be mined and used to generate electricity or provide domestic heating.

(iii) Nuclear energy, apart from the risks it presents, is only suitable for producing high voltages and is not well suited to the needs of developing countries. The economics of low-voltage reactors are uncertain.

(iv) Hydroelectric power is another important potential source of energy as long as small-scale hydroelectric installations are developed to harness small waterfalls (approximately 5 million) or river currents at suitable points, thereby meeting the developing countries' localized energy demand.

(v) Alternative sources of energy (solar energy, geothermal energy) represent an important means of remedying international inequalities and are attractive to the developing countries for various reasons: natural conditions are generally favourable (sunshine), the social structures are better adapted to a dispersed and decentralized system of administration and, lastly, energy demand per unit of surface area is generally low (low consumption distributed over vast areas). The last factor applies to Africa in particular.

The ACP States energy dependence

Of the developing countries, the ACP States as a whole have by far the lowest annual *per capita* consumption of energy: 85 kg oil equivalent as against an overall Third World average of 300, 3 toe in Europe and 7.5 toe in the United States,

A number of ACP States are well below the average: a native of Burundi, for example, has an annual energy consumption of 8 kg oil equivalent, which is nearly a thousand times less than the average American.

Despite this low consumption, the ACP States are very largely dependent on oil imports: 80% of the energy consumed is derived from oil, while only four countries are oil producers (Nigeria, Gabon, Trinidad and Tobago, the Congo).

The other sources of energy used are as follows: coal, used in significant quantities in only four countries (Zaire, Zambia, Nigeria and Somalia), natural gas (Trinidad and Tobago, Nigeria, the Congo and Gabon) and hydroelectric power (Zambia, Ghana, Nigeria, Cameroon, Surinam and Ethiopia).

Recovery based on union

Price increases, growing balance of payments deficits, less disposable income to spend on non-energy consumption, heightened conflict between oil producers and consumers and among consumers themselves ... this is roughly the picture which can be painted of a non-concerted world economy following another increase in the price of oil. Hence the Bremen and Bonn statements advocating greater cooperation with the Third World.

One has to be fairly optimistic to talk of recovery based on cooperation between industrialized and developing countries in the energy field. It would be more correct to speak of removing obstacles to recovery. By providing the developing countries with assistance to develop new sources of energy and thereby partially liberating them from the financial constraints which energy imports impose on their development, the industrialized countries would also benefit as a result of the demand created in those countries. The industrialized countries, Europe in particular, are increasingly aware of the fact that any recovery in their economic growth can only be lasting if their efforts are supported by external demand from their partners in the developing countries.

With this in mind, it has been widely stressed, particularly in the OECD, that energy is one of the key areas for the implementation of a programme for the transfer of resources to the developing countries.

Naturally, this is one aspect of a policy at world level. For its part, the European Community has a specific role to play, especially in view of its special relations with a large part of the Third World.

Indeed, although it is possible to envisage very broad cooperation in the case of some types of project, such as an inventory of the developing countries' energy resources or the development of new technologies, a narrower framework is desirable for the implementation of specific, practical programmes.

The Community's range of action

Naturally, Community action in the energy cooperation field is most likely to be effective and swift wherever cooperation instruments and financial resources already exist, provided, however, that this kind of cooperation is what is wanted by the partners with whom the Community intends to undertake the action in question. The ACP-EEC Convention, which provides for a wide range of cooperation instruments, including the European Development Fund and the European Investment Bank, is certainly the most suitable framework. As will be shown below, a start has already been made on cooperation of this kind.

Cooperation in the sphere of energy has also been undertaken within the framework of the Maghreb and Mashreq Agreements.

In all the countries referred to above, it seems likely that solar energy will be able to offset many of the constraints on national economic and social development. Of course, a landlocked or island country has quite different needs from an oil-producing country or one endowed with considerable hydroelectric resources. Hence the attraction of a flexible and pragmatic policy.

On the other hand, the existing specifically Community research structures (the Joint Research Centre at Ispra already has research facilities at its disposal which could be used to help developing countries as well as the Community countries) and the Community's probable participation in schemes being organized on a broader scale, within the framework of the Euro-Arab Dialogue, the North-South Dialogue or certain United Nations organizations (notably, the holding in 1981 of an ECOSOC conference on new and renewable energy resources), in other words an overall Community approach, are bound to have a favourable effect on the projects carried out with the ACP countries.

SOLAR ENERGY IN THE SERVICE OF DEVELOPMENT

Definitions

When discussing new energy sources, a number of terms and expressions are widely used. They are not always synonymous and this results in a certain confusion.

'Alternative energy' is a term which covers all the forms of energy except those derived from coal, oil or nuclear power.

'Renewable energy sources' covers all the energy sources that are available in a usable form, i.e. the sun's rays, tides, wind, hot springs, etc., but are not depleted by conversion into electrical or mechanical power.

'Solar energy' covers all the renewable forms of energy derived from the sun, either directly (by direct photovoltaic conversion) or indirectly (by thermal conversion and use of the biomass or wind power). Small-scale waterpower installations, which appear to be able to meet the same localized requirements are treated in conjunction with solar energy. More sophisticated techniques, such as the use of the thermal gradients which exist in tropical waters (OTEC) or even solar power stations equipped with giant heliostats, which are being developed in the industrialized countries, require much larger investments and, for this reason, are not often listed as possible uses of solar energy in developing countries.

Present applications of solar energy in the developing countries

Wood and organic waste are the principal fuels used in developing countries.

One of the obvious features of developing countries is the lack of infrastructure for transmitting electricity in rural areas. This is particularly true in Africa where population density is one of the lowest in the world. A very small proportion of the wood and organic waste burned is converted into electricity, most of it being used directly for domestic purposes. There is therefore obviously a need for small, decentralized installations, capable of producing the few hundred watts needed to meet the requirements of the rural population. Energy in such small quantities could be supplied by one generator in each village or else by small individual installations for each dwelling. Many villages are already equipped with small diesel generators but these are expensive to maintain and fuel and give rise to a considerable wastage of energy because of the difficulties in rationalizing their use.

Solar energy makes it possible to use individual installations to produce limited quantities of electrical or mechanical energy to meet the needs of a small group of individuals or of a family.

If we take as our starting-point the energy requirements of villagers in the Third World, it becomes apparent that, in most cases, the most appropriate usable source of energy is solar.

For cooking purposes, in particular, the villager needs a source of energy which provides temperatures of more than 100° C. Temperatures of this kind cannot be obtained by direct radiation. However, thousands of small cookers powered by a biomass method are being used in the Chinese countryside. This method makes it possible to use all kinds of waste as back-up source of energy.

Biogas cookers (biomass method) work off a gas produced from organic waste and sewage water. They are socially acceptable in that the gases are produced outside and are piped to the spot where the food is being prepared.

In China this method of cooking food has yielded excellent results. In India, on the other hand, this experiment has been less successful: the equipment was considered too expensive and the steel used in its construction was found to rust in some cases.

The lighting requirements for a village family are relatively small (a few hundred watts used after sundown). There are considerable advantages in using solar energy to power small electricity generating stations in villages. Solar units of this kind can generate up to 370 kW per day, with a peak output of 25 kWh, to power dwellings, the local dispensary or health installations in general, administrative premises and workshops or a mill or pumping station.

Of course, villagers also need water and water-pumping is one of the most widespread uses of solar energy. There are three possible types of pump: the solar heat pump, the photovoltaic pump, and the wind pump. Two types of solar pump are currently available on the market: one works by storing heat on solar plates using the greenhouse principle. This technology is particularly suitable for small agricultural areas. The second type works by photosynthesis.

Solar energy is also used in the processing of certain crops, for example for drying tobacco in Malawi and fish in the Sahel region. Experiments on crop-drying processes using solar energy are being conducted in a number of countries: The Philippines, Brazil, India, etc.

Lastly, the telecommunications sector is a prime candidate for radical change as a result of the possibilities offered by solar technology. The first experiments into the use of photovoltaic equipment to power educational television networks were undertaken in the Niger in 1968.

Since then, the use of photovoltaic panels to power television sets has become widespread. At present this technology is being used as part of a world-wide literacy campaign. In Togo, solar modules will very shortly be installed to provide electricity for a programme of educational television broadcasts to the rural population. Relay stations will be powered by solar cells.

In Zaire, the use of solar cells to power a telephone link is proving very successful. The Government also intends to use this technology to run 50 power stations each generating 100 watts and operating 24 hours per day.

In Jordan, 32 rural telephones and about 100 emergency phones on the main roads are already being powered by solar energy. None of these could have been installed but for the use of photovoltaic cells.

Solar energy therefore not only helps to bring about a better lifestyle but also helps to improve the quality of life.

Current developments in solar technology

Solar energy can be converted into electricity or mechanical power using motors linked to solar collectors. The disadvantage of systems using solar panel collectors is their bulk, since the panels generally cover a large area given the very low output per square metre. An area of approximately 80 m² is needed to produce 1 kW of electricity. Moreover, to operate a system of this kind continuously a means has to be found of storing the energy produced during the day.

This technique can be refined with the help of mechanisms for concentrating the solar radiation using mirrors (ordinary mirrors, parabolic mirrors or Fresnel lenses — temperatures of 300°C can be achieved using the third method). However, both ordinary mirrors and the more sophisticated methods of concentrating solar radiation require continuous maintenance, which must be carried out by qualified staff, to ensure efficient operation.

Research has already reached a more advanced stage and important work is at present being carried out in certain developing countries to perfect 50 kW output installations equipped with cylindro-parabolic collectors and worm-geared motors.

At the same time, research is also being carried out into meteorological conditions in certain areas.

The direct conversion of solar radiation into electricity has been made possible by the development of solar cells which operate on the basis of junctions in semiconductor materials. These are photovoltaic solar panels. These installations do not have any moving parts so that the maintenance required is minimal and it is possible to generate electricity continously over a long period. The process of solar radiation conversion is not dependent on the intensity of the sun's rays which means that this system can easily cope with considerable variations in radiation strength. Progress has already been made by experimenting with the materials used in cell manufacture. As a result, silicon cells have been introduced with great success in several countries.

As regards the surface area needed, the photovoltaic cell technique clearly has important advantages since, for a maximum output of 1 kW, the required panel area is only 30 m^2.

The use of biomass to generate power is an attractive technique provided that sufficient quantities of waste are available from agricultural processing or vegetable sources or that it is possible to produce the biomass from special crops (for example, eucalyptus, particularly useful on account of its prolific growth, could be grown in special plantations). The biomass is converted into energy by a simple fermentation process (microbiological conversion), or by pyrolysis and gasification into low-grade liquids or gas, which are easy to store, or by distillation to produce alcohol. These products are then used to generate electricity or mechanical power. At that stage, it is possible, with little adjustment, to use an internal combustion engine. For exemple, alcohol can be mixed with petrol in a 15% to 85% mix. In Brazil, where much experimentation has been done in this field, it is hoped to perfect a car in the very near future which will run on 100% ethanol, alcohol produced from biomass, thereby reducing oil imports.

Lastly, as regards wind power, research is being carried out on a number of systems (horizontal and vertical) for harnessing this energy source. The windmill principle, refined by the use of modern materials and techniques, is still the most widely-used system. Although there are still considerable problems of maintenance and control, this is a particularly economical way of generating power in regions where the climatic conditions are suitable. The basic outlay for a small installation (including tower and storage system) is approximately USD 1 000. However, this system is restricted to mountainous and coastal areas. Consideration has also been given to the erection of off-shore wind power generating plants. A number of problems concerning the regularity of wind power as a source of energy have not yet been solved. Very high winds as well as lack of wind are still obvious obstacles and attempts are being made to overcome these using new technologies.

Indirect effects of solar technology on development

Industrialization and transfer of technology

Solar energy technology covers a whole spectrum of approaches from the most simple apparatus to the most complicated: from the plastic greenhouses used in farming to technologically very advanced silicon cells. It is, of course, desirable that most of the components used in generating power from solar energy should be manufactured in the countries using them. However, this is not always possible.

Regional cooperation among developing countries facilitates the setting up of the industrial infrastructure necessary to manufacture at least some of the solar equipment. Complementary specialization by the various countries, whereby each country is responsible for the manufacture of certain parts or types of equipment, is in fact the best means of encouraging the transfer of technology to a whole region. Of course, staff training is the crucial factor.

In general, when designing and manufacturing this equipment, the firms involved in this local production must, of course, try to take advantage of the country's material and human resources and also its traditional lines of production. For a transfer of technology really to be possible, account has to be taken of manufacturing codes and standards, the existing capacities of the local labour force, construction methods used, the type and size of markets and the economic and social conditions obtaining in the country or group of countries in question.

Training

The help of specialists at all levels is needed to apply the existing solar technology. There are already training opportunities available, such as the training seminar organized by UNESCO in Perpignan, France, and the services made available to Third World experts by the European Commission's Research Centre at Ispra in Italy. Several other international organizations also hold regular training sessions on solar energy.

In Africa, ONERSOL has organized a training course in the Niger, and funds are available under the Lomé Convention for training and could be used for the training of solar technicians at national or, preferably, regional level.

Social implications

The use of solar energy has important ecological implications. The use of wood for fuel in rural areas has already resulted in deforestation, which, in general, it is desirable to prevent for fear of destroying the ecological equilibrium in certain regions. Similarly, the use of manure for fuel means impoverishment of the soil. Solar energy provides an attractive alternative.

In rural areas, the social advantages of solar energy are obvious since it provides peasants with an additional source of energy which leads to an improvement in living conditions, crop yields and the food situation in general. Nevertheless, it would be a mistake to minimize the social effects of introducing the new technology into an environment in which traditions still play an important part. Although, as in Mali, the peasants can welcome this new technology, there are also instances where the introduction of solar pumps and biomass cookers has been totally rejected or has brought about a brutal disruption of the traditional environment. One can never overstress the importance of educating and informing the public, particularly in rural areas, before introducing solar equipment.

EEC-ACP COOPERATION ON SOLAR ENERGY: THE FIRST CAUTIOUS STEPS

The Lomé Convention does not deal specifically with promoting cooperation in the energy field. However, several solar projects or solar components in rural development projects have been or will be undertaken on the initiative of non-governmental organizations operating in these countries, or of governmental or semi-governmental bodies such as ONERSOL in the Niger or in response to proposals by the European Commission. Those installations which have been set up are proving successful, albeit on a limited experimental scale. However, these initial projects have revealed one of the major obstacles to a more extensive development of solar energy in the ACP countries, namely the lack of information on the possibilities offered by this new form of energy.

In preparation for the UN Conference on Science and Technology for Development, the Commission organized an international conference on solar energy in Italy from 26 to 29 March this year. At this conference, 300 participants from all over the world were invited to exchange their experiences in the solar field. Five preparatory regional seminars were held in September and October of last year in Nairobi for East Africa, Bamako for West Africa, Amman for the Arab countries, Caracas for Latin America and New Delhi for South and South-East Asia. These seminars, which were warmly welcomed by the governments concerned and by national energy officials, provided an opportunity to prepare plans of action, taking account of current activities and the needs of the various countries, for the increased use of solar energy in each of the regions concerned. These seminars did much more than merely provide an opportunity for experts to exchange ideas: very practical aspects of international cooperation in the field of solar energy were also tackled, such as project financing, transfer of technology and opportunities for research and regional cooperation.

This was very practical work paving the way for an unprecedented development of projects using solar energy under the new ACP-EEC Convention and also under the agreements concluded by the EEC with certain Arab countries and even in the context of the cooperation which is slowly being instituted with the members of ASEAN and the countries of southern Asia.

The Lomé Convention: The beginnings of ACP-EEC cooperation

Up to the beginning of this year, the cooperation between the EEC and ACP States in the field of solar energy has been at a modest level. It was on 15 March 1977 that the Commission approved the financing by the European Development Fund (EDF) of the very first project involving the use of solar energy: the installation of a 10 kW solar pump to irrigate a 20 hectare rice-growing area in the Senegal River Valley in Mauritania. This pump is expected to become operational in June this year. This project was followed by eight others (see annexed list). In addition, the Commission helped to finance two studies on the feasibility of producing alcohol from sugar-cane waste in Upper Volta and the Sudan. In the Sudan, the study indicated that it would be economic to use this kind of technology on the basis of an annual production of 16 000 tonnes of alcohol to be mixed with motor fuel. In Upper Volta, tests will be carried out to establish whether it will be technically feasible and economic to produce 2 400 tonnes of alcohol annually from 10 000 tonnes of unused molasses from the Banfora sugar refinery. This alcohol is intended to replace a large part of the timber at present burned to provide heating in the town of Ouagadougou.

Although the Mauritanian project was the first solar project to be financed directly by the EDF, mention should be made of several small solar installations which were financed indirectly by the EDF at the request of non-governmental organizations. These installations, which, with the exception of the one at Yangasso in Mali, have an output of 1 kW or less, have the advantage of meeting directly the requirements of the local population in areas generally lacking in any other form of energy (see annexed list).

By the end of 1978 EDF financing of projects related to solar energy totalled 3 095 000 EUA (1 EUA = USD 1.20), which us a derisory sum compared with the 2 300 million EUA committed for all projects or the 188 million EUA earmarked for energy projects.

There are several reasons for this. Firstly, none of the texts of the Lomé Convention refers specifically to promoting cooperation in the energy sector (in three headings of the Convention the word 'energy' is used only once, namely in Title III, Industrial Cooperation, in Title IV, Financial and Technical Cooperation and in Protocol No 2 on the application of financial and technical cooperation). Secondly, since EDF resources are allocated on the basis of indicative aid programmes established by the States in the light of their development priorities, there were very few States in 1976, the year in which most of the indicative programmes were drawn up, that were sufficiently well informed about solar technology to want to allocate substantial funds to this sector.

However this is not the EDF's last word on the subject. Almost one third of the funds available under the fourth EDF are still to be committed to projects before the expiry of the present Convention.

Already several solar projects of regional interest have been proposed for financing under the second instalment of funds earmarked for regional cooperation. They include the installing of digestors for producing methane gas by fermentation, the choosing of sites and the educating of users prior to setting up small-scale water-power installations and, lastly, the development of gas producers. These projects are concerned in particular with two areas: the Sahel and tropical central Africa (Zaire, Rwanda, Burundi, Kenya and Tanzania). In addition, there are plans to finance, for the benefit of all the ACP countries, an inventory of the solar energy potential of each region. This request emerged from the regional preparatory seminars for the international conference on solar energy as an aid to development organized by the Commission in liaison with the Joint Research Centre at Ispra.

To be fully comprehensive, two further arguments should be added to justify the caution which the Commission has shown hitherto:

Firstly, the still prohibitive cost of solar equipment continues to act as a deterrent to its widespread application, particularly as it has been shown that, of the possible means of economizing on petroleum products open to the ACP countries, the solar alternative is still the most expensive. In most of the ACP countries, studies have shown that sensible management of existing diesel installations and improved efficiency would, in some cases, make energy savings of 50% of consumption possible. As an illustration, it costs 0.046 EUA to pump a cubic metre of water with a 21 h.p. diesel installation, 0.217 EUA using a 10 kW photovoltaic installation and 0.267 EUA using a thermodynamic installation. On the other hand, for outputs of up to 5 kW, photovoltaic installations are very cost efficient (the annual running cost, including amortization, of a 900 watts photovoltaic pump is 2 635 EUA compared with an average cost of 3 322 EUA for a diesel equivalent).

The second factor is that solar technologies are not yet able to give rise to large-scale transfers of technology to the ACP States.

Nevertheless, with a view to giving national governments the best possible advice as to their choice of projects and in order to encourage the spread of new technologies, the Commission has examined very systematically the scope for incorporating solar equipment in the projects, particularly in the field of rural development, carried out in the context of financial and technical cooperation under the Lomé Convention.

The basis for future cooperation

Energy cooperation will doubtless be an important aspect of the new ACP-EEC Convention, but how much emphasis will be placed on solar energy is still an open question. Although the ACP countries offer a fertile market on which equipment manufacturers already have an eye, the Commission is not going to add to the scramble for contracts. On the contrary, it should not depart from the prudent attitude which, up to the present, has led to success in the solar energy operations carried out in collaboration with the ACP countries.

The conclusions of the Varese international conference on solar energy as an aid to development will provide the basis for an assessment of all the existing installations. Regional seminars have already revealed the needs and possible scope for projects using solar energy. All the information contained in this new document will provide the ACP countries and the EEC alike with a very firm basis for commitment. The first step in the implementation of this new technology will then have been completed.

SOLAR ENERGY AND THE 1980-83 MULTIANNUAL RESEARCH PROGRAMME

The Joint Research Centre's new Multiannual Research Programme for 1980-83, which was recently adopted by the Commission of the European Communities and the European Parliament, will now be submitted to a forthcoming Council meeting on research for adoption before the end of the year.

While this Programme, which from 1 January 1980 will extend and replace the present Multiannual Programme covering the period from 1 January 1977 to 31 December 1980, lays particular stress on nuclear safety, it does not neglect new forms of energy and solar energy in particular.

The role of the Joint Research Centre

The Joint Research Centre comprises four different establishments: Geel (Belgium), Ispra (Italy), Karlsruhe (Federal Republic of Germany) and Petten (Netherlands), with a total staff of 2 260, and carries out the European Communities' own research in the form of direct action. These establishments, through their size and the permanent nature of their installations, make it possible to carry out projects and experiments whose scope often exceeds the resources of the individual Member States.

Thus under the common policy for science and technology the JRC performs the following functions:

- *the execution of programmes of a 'central' nature* which justify the establishment of a broad research potential at Community level and which call for the centralization of experimental facilities or know-how, in which the JRC can act as a catalyst for coordination between the Member States;
- *the performance of a public service role* by meeting the needs of Government organizations, universities and industry for specialized equipment, know-how, products and services;
- *the provision of services to the Community.* The JRC acts as the Commission's own tool by making available to it skills and scientific and technical support for the preparation and implementation of common sectoral policies.

The new 1980-83 Research Programme

The new programme, the cost of which is estimated at 543 million EUA (1 EUA = approximately USD 1.35), focuses on six topics.

Nuclear safety and the fuel cycle

The new programme continues and intensifies in particular the research effort in this area.

Therefore, in addition to the Super SARA project which will be carried out at Ispra (in collaboration with the US Nuclear Regulatory Commission) using the ESSOR reactor and which is intended for the study of fuel behaviour in the event of a loss of reactor coolant, activities will focus on other aspects of the safety of light water and fast-breeder reactors.

- LOBI project: an out-of-pile experimental study of loss of coolant in light water reactors;
- PAHR in-pile project: a theoretical and experimental study of molten core behaviours, including in-pile tests.

Research will be continued on aspects of the safety of the plutonium fuel cycle (work in progress mainly at Karlsruhe), on problems connected with the permanent storage of radioactive waste and on reinforcing safeguards and management of fissile materials.

New forms of energy

The JRC will pursue a number of its own specialized projects in the field of solar energy: the ESTI project, the Habitat project and basis research on the new conversion and storage processes. In addition, the solar energy programme provides for technical assistance to the developing countries (*see the details of the programme below*).

As regards hydrogen, the JRC will direct its activities towards hydrogen as an energy vector. It will continue its work on the technological problems connected with thermonuclear fusion including a contribution to post-JET machine design studies. Lastly, the JRC will study the materials which will be needed for the future high-temperature energy systems.

Environmental studies and protection

Apart from a project devoted to the theoretical and experimental study of the environmental impact of fossil-fuelled power stations, all these projects in the new programme deal with the problem of the introduction of toxic chemical substances into the environment.

Nuclear measurements

This programme, which is mainly to be carried out at the Central Bureau for Nuclear Measurements at Geel, is based on the measurement of nuclear data using the establishment's large accelerators, the preparation of nuclear reference materials and techniques, and the dissemination of information on radiation protection shielding.

Specific support for the Commission's sectoral activities

This programme includes research on advanced computer applications. In the field of safeguards, it will act as a reference laboratory for analysing samples taken during inspections and will provide technical assistance for the Safeguards Directorate.

Operation of major installations

For the moment, only one programme comes under this heading: the operation of the Petten High Flux Reactor (HFR), which will be continued for the benefit of the Member States' research programmes and the JRC's own needs.

Solar energy and the JRC Programme

The Programme proposed for the period 1980-83 has two basic objectives:

- to continue research in certain specific areas, and
- to use, with optimum efficiency, the test installations at Ispra which give a concrete expression to the part played by the JRC and to its public service role.

Starting from this viewpoint, the 1980-83 Programme is divided into three projects:

- European Solar Test Installation (ESTI);
- the use of solar energy in the habitat and low-temperature applications; materials for solar power plants;
- photoelectrochemical and photochemical conversion.

European Solar Test Installation

This project will comprise the construction and operation of facilities for testing photothermal and photovoltaic converters with a view to obtaining reliable values for their expected performance and service life. The first facilities will become operational at the end of 1979. The goal of this activity is to provide manufacturers and potential solar system users with a powerful tool for assessing the quality of solar energy conversion equipment.

The specific testing activities will be carried out in conjunction with support activities such as the identification of degradation processes, the development of test methods, and the definition, with the collaboration of national expert groups, of codes of conduct for the qualification of solar components.

The JRC will also participate in the establishment of a European Solar Information Service, which is intended to be set up in one of the Member States.

The use of solar energy in the habitat and other low-temperature applications; solar power plant materials

The Habitat project, which is a continuation of the present programme, is concerned mainly with the development of solar systems likely to ensure year-round utilization of the solar collectors either by combining solar heating with solar cooling or by adding seasonal heat storage in order to improve the economic efficiency of such a system. The proposal also deals with the use of solar heat for certain industrial or agricultural processes for which temperatures in the 100 – 150°C range are needed (concentrating collectors with tracking devices).

As regards the combined solar heating and cooling systems, which are of particular interest to the developing countries, studies should demonstrate the feasibility of using collectors with low concentration ratios. The determination of a methodology for monitoring and modelling such systems is an essential part of the project.

The development of solar heat sources for industrial and agricultural applications also concerns the developing countries: the proposed activity aims to set up a solar system for producing process heat up to 150°C, to investigate the related technological problems, and to monitor and determine performance. There are also plans for coupling this system with a small distilling tower (methanol production).

Another part of this programme aims to contribute to the improvement of the cost effectiveness of tower-type solar power plants through an appropriate programme of materials and concept evaluation. Particular attention will be paid to the 1 MW solar power plant to be built in Sicily by the ANSALDO-ENEL-CETHEL consortium under the current indirect-action programme.

Photoelectrochemical and photochemical conversion

The aim of this activity is to research into new low-cost direct conversion techniques based on photoelectrochemical and photochemical methods. These methods allow solar energy to be converted into not only electricity but also chemical energy and therefore offer the potential advantage of also solving the storage problem, which is one of the major problems encountered in the use of solar energy.

Also under this programme, consideration will have to be given to ad hoc JRC contributions in the field of technical assistance to the developing countries which are associated with the Community by agreements covering science and technology.

Activities connected with solar energy and the developing countries

Apart from the JRC programme, the Commission of the European Communities endeavoured, during a symposium held on 26-29 March at Varese, Italy, the main topic of which was 'Solar energy in the service of the developing countries', more accurately to define the needs of the developing countries in this field and to look for methods of rationalizing research activities and efforts in this area.

After three days of discussion in which more than 250 representatives from Africa, Latin America, Europe and the Middle East took part, it was clear that, while the industrial use of solar energy seemed hardly feasible because of the cost and sophisticated nature of the equipment, on the other hand the use of solar energy for domestic purposes as a means of acquiring energy independence in a rural or village environment should be developed.

The European Community can for its part help the developing countries to develop this technology either by proposing projects or helping to finance them, or by conducting research into the specific or sectoral needs of these countries.

The Commission of the European Communities would like to see a greater number of microprojects (solar pumps, solar furnaces, solar televisions) corresponding to precise needs conducted under the next Lomé Convention.

Summary table

Programme: B.1. Solar energy

Project	Specific appropriations				Research staff
	Operating expenditure	Investments	Contracts	Total	
1. ESTI	831	1 613	369	2 813	29
2. Habitat	488	973	178	1 639	21
3. Solar power plants	231	189	98	518	7
4. PPC	179	158	74	411	6
Total	1 729	2 933	719	5 381	63[1]
1980	350	1 225	192	1 767	
1981	420	891	198	1 509	
1982	459	511	183	1 153	
1983	500	306	146	952	

[1] Research staff of 33 were allocated to the corresponding programme in the period 1977-80

Alternative energy sources — project situation at 1 May 1979

Title	Country	Cost in EUA	Remarks
1. Geothermical energy	Ethiopia	4 100 000	In progress
2. Intensification of agricultural production in Senegal River valley (one 10 kW solar pump)	Mauritania	475 000	In progress
3. Construction of solar pumps and engines — Phase I (one 10 kW and one 5 kW pump)	Niger	550 000	In progress
4. Constuction of solar pumps and engines — Phase II (prototype solar engine with thermodynamic cycle)	Niger	550 000	At the invitation to tender stage
5. Village water engineering programme in Togo (Two 900 W pumps)	Togo	80 000	In progress
6. Agricultural development (air-conditioning for a research centre)	Barbados	25 000	Completed
7. Rural development scheme in the Department of Badéguichéri (heating of water for sanitary purposes	Niger	5 000	At the invitation to tender stage
8. Supply of electricity for a microwawe relay	Comoros	200 000	At the invitation to tender stage
9. Irrigated rice growing in the Logone and Chari district (one 5 kW solar pump)	Cameroon	350 000	At the invitation to tender stage
10. Heating of water for sanitary purposes in a hospital	Malawi	100 000	At the invitation to tender stage
11. Use of molasses (study)	Upper Volta	80 000	Completed
12. Use of molasses (study)	Sudan	115 000	In progress
13. Conversion of ocean heat energy (study)	Ivory Coast	200 000	At the invitation to tender stage
14. Conversion of ocean heat energy (study)	Netherlands Antilles	160 000	At the invitation to tender stage
15. Utilization of plant wastes (study)	Ivory Coast	100 000	At the invitation to tender stage
16. Biogases	Rwanda, Burundi Upper Volta	300 000	At the invitation to tender stage
NGOs			
1. Equipment of 3 boreholes with solar pumps operating on photovoltaic cells in Mali, in the San district	Mali	60 000	Completed
2. Solar pump project in Kahel (1 kW)	Senegal	75 000	In progress
3. Solar pump project in Yangasso (1.3 kW)	Mali	85 000	In progress
4. Solar pump project in Timbuctoo (1 kW)	Mali	75 000	In progress
5. Solar pump project in Thies (9 × 1 kW)	Senegal	250 000	In progress
6. Solar pump project in Yangasso (1.3 kW)	Mali	21 000	At the invitation to tender stage
7. Equipment of a borehole with a solar pump in Safolo (1.3 kW)	Mali	35 000	At the invitation to tender stage
Total		7 991 000	

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