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PHOTOVOLTAIC ENERGY AS A DEVELOPMENT AID

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PHOTOVOLTAIC ENERGY AS A DEVELOPMENT AID

1. Technology derived from space exploration

The general use of solar cells, which turn light into electricity and were formerly reserved for space technology, is no longer a remote dream.

Without solar cells carried by satellites to power their electronic control and communication systems - for weeks, months or even years at a time - the conquest of space would have been inconceivable.

Since solar cells were first used, in space, the scope of their applications has widened to embrace several thousand equipments currently operational throughout the world. The most widespread use is in telecommunications (micro-wave links, television relay transmitters and television sets), radio and light beacons and water pumping.

In the next decade photovoltaic energy will be chiefly used in the most remote regions of the planet, far from electricity grids, in activities connected with agricultural and rural development and in telecommunications.

Photovoltaic energy is not a solution to the energy crisis, because it will be too expensive for a long time yet compared with electricity from hydro or nuclear sources and even with electricity generated by coal - or oil-fired power stations.

Since the cost of conventional energy is going up and that of photovoltaic modules continues to fall, the energy obtained from solar cells is becoming cost-effective in an increasing number of applications.

2. Marginal but very important applications

Electricity from solar cells costs a great deal to produce, but practically nothing to transport, because the generator is connected directly to the apparatus which uses the current. As a rule, photovoltaic appliances also require less maintenance than generators driven, say, by diesel engines.

Photovoltaic energy is suitable, therefore, when a small amount of energy is needed, most often in places not connected to existing grids, and where it is too costly to transport conventional fuels such as diesel. This is generally the case in the developing countries, whose energy requirements, while not high, are often dispersed.

Solar cells make it possible to bring electricity for lighting, pumping water, refrigeration, radio and telephone communications and television to the most remote areas.

A rural region will see its standard of living and agricultural productivity improved by this form of energy. Photovoltaic electricity may prove a tailor-made energy source for remote villages and sites. There will be no need to wait for a large power station or long-distance grid to be built before receiving the essential minimum of electricity.

Solar-cell systems are of modular design. A small number of modules may be used to start with, thus generating enough current to light a house, or run a refrigerator or water pump. Other modules may be added as energy requirements increase.

In remote regions which have no electricity supply and where the only alternative is a diesel generator, photovoltaic units may provide a viable answer, especially for small communities.

3. Market prospects

Photovoltaic energy will cease to be marginal only if it gains a price advantage over conventional energy systems. Much work still has to be done before solar-cell energy can be generated at rates which are competitive with other sources.

The Americans hope that by 1986 the cost of photovoltaic energy will be brought down to a level attractive to the household user and that the surplus current produced by American consumers with their own solar equipment can be fed into the grid.

To encourage this way of making photovoltaic generators a paying proposition Congress has passed a law obliging electricity utilities to purchase surplus current from users for at least half what the consumer pays.

The Americans think that photovoltaic energy will be competitive when the cost of producing a watt module is less than 40 cents, which is one-tenth of the current price. According to US official estimates this goal could be reached in 1986.

European experts are much less optimistic about the future trend of production costs. According to Mr. C. Durand, Chairman of the French Solar Energy Commission, the French industry is hoping to bring the price of a watt module down to US-Dollar 2.50 in five or six years' time, and the price of a watt system to US-Dollar 10-12. (A solar module means a collection of photovoltaic cells, a "system" includes all the components needed to make a photovoltaic generator.)

A square metre of cell-area will today give 80 to 125 watts, depending on the climate.

The key problem, then, with the widescale application of photovoltaic energy is the cost of production. The market will grow as the production cost falls and approaches that of other energy sources. But the opposite is also true, namely that market growth is an essential condition for lower prices as a result of the production of solar modules on a large scale.

Given that electricity costs at least as much to distribute as it does to generate, it is likely that photovoltaic energy may, in a few years time, become worthwhile for those sites which are not already connected to the grid and where the transmission distance is more than 2 or 3 kilometres.

Photovoltaic generators are often considered as alternatives to diesel generating sets, a typical example being the small generators supplying a village with electricity or perhaps just a water pump.

The continued rise in oil prices also encourages the wider use of photovoltaic electricity, especially as, in addition to the cost of purchasing the fuel, there are supply problems and considerable transport costs.

Energy consumption today in the developing countries is ten times smaller on average than in European countries. All the experts agree that the world demand for energy in the next twenty years will go up faster than supply, and so oil prices will continue to rise.

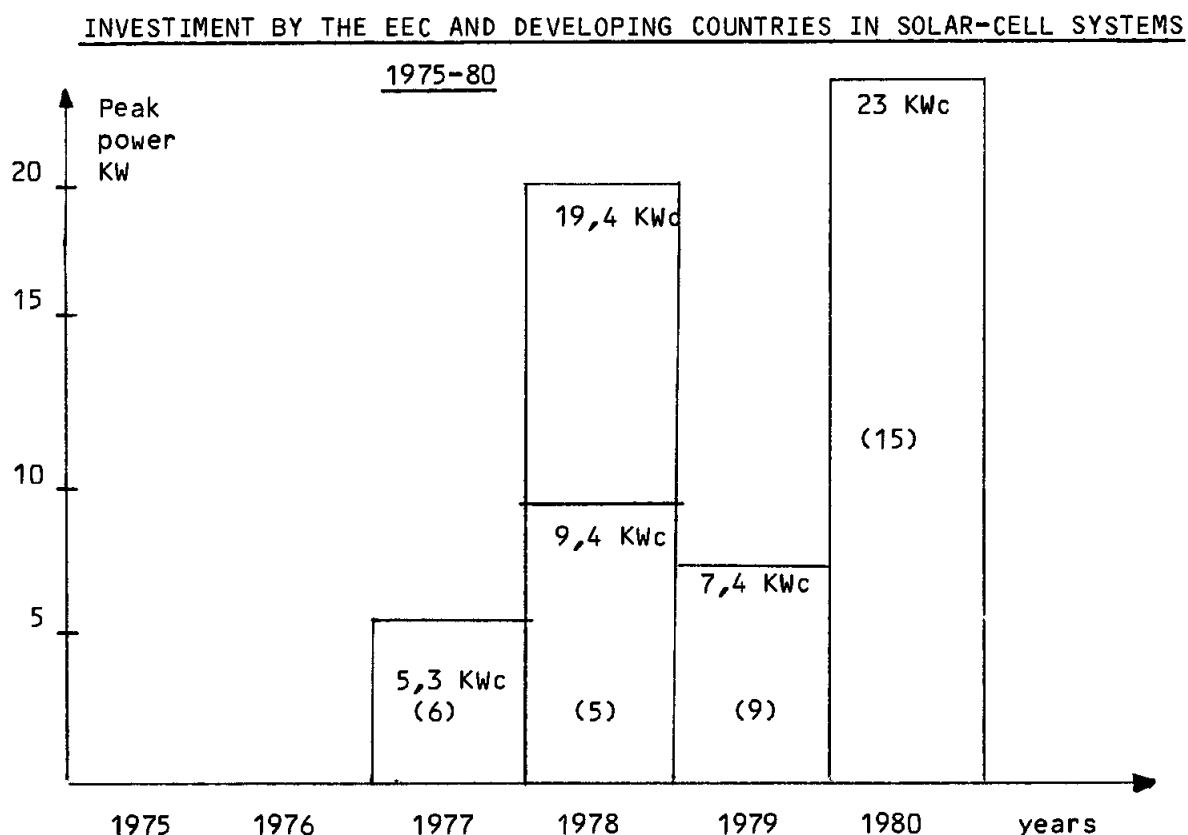
Between now and the year 2000, although photovoltaic energy will be used more and more, it will probably still only account for less than 1% of the Community's electricity consumption.

In some developing countries, however, in which the climate is favourable and which have some technological know-how and adequate finance, it can make a much greater contribution to the energy balance.

4. Measures taken by the European Community

Between 1975 and 1980 the European Community granted financial assistance to a number of projects using new and renewable energy sources in the developing countries.

A total of US-Dollar 48 million was spent on all the projects developed under this cooperation scheme, of which US-Dollar 4 million, or 8.5%, was allocated to photovoltaic projects. The following table shows the amounts spent on solar-cell systems.



Several African, Caribbean, Pacific, Mediterranean and Asian countries, as well as many non-governmental organizations, received Community aid for projects using new and renewable sources of energy. The objectives of the projects were as follows:

- (i) to study the local potential for energy diversification and the optimum use of resources;
- (ii) to promote new solutions to the energy problems of rural areas by employing locally suitable demonstration equipment of proven reliability;
- (iii) to integrate these new technologies into conventional projects financed by the EEC with a view to making its operations less dependent on the supply of oil products;
- (iv) to transfer know-how, of relevance primarily to scientific and technical operators;
- (v) to make use of environmentally favourable technologies and to improve energy management.

Now that the first generation of "new-energy" projects is complete, it is time for a preliminary review of results and problems. To guide them in the future, those concerned with new energy projects (government and aid-organization officials, equipment manufacturers, research workers, etc.) need to know what can be learnt from current experiments. This should include much information on total capital cost, performance, equipment reliability, acceptance of the equipment by the local population and its effects on community development, the correctness of siting, maintenance problems, etc.

The only way to evaluate the systems is to study a few significant experiments; a methodology can then be devised for preparing, carrying out and following-up projects which utilize solar energy.

Four ACP States (Cameroon, Mali, Niger and Senegal) have agreed to this idea and have set up a regional scheme for reviewing the results obtained in each ACP State where such units are already installed. The Commission of the European Communities will coordinate this operation.

This review is now being carried out by an international consultancy and should be finished early in 1981.

Some conclusions can already be drawn, however, from the field experiments conducted so far. An expert in the Directorate-General for Development in the Commission of the European Communities, responsible for scientific cooperation projects, summarizes these results as follows:

"There is no doubt that in a few years time renewable sources of energy will be able to meet a fairly large part of developing countries' energy requirements.

Inadequate knowledge of resources and real requirements is a major element of uncertainty in the selection and execution of projects. The systems and equipments now on the market are still too expensive and not sufficiently reliable for widespread use. We are therefore obliged at the moment to confine ourselves to demonstration projects and scientific cooperation schemes which must be coordinated within a framework of better-harmonized national and regional science policies development.

"Paradoxically, it is not a lack of financial resources which is curbing the development of this technology but the way they are used and allocated among the various tasks to be completed.

"As most of the equipment using new sources of energy is still at the R&D stage, considerable adaptations have to be made, and a thorough knowledge of the potential of this kind of technology is required, before such equipment can be installed in the developing countries.

"The often deep-rooted habits which have to be overcome if this technology is to catch on are a problem which must be tackled with care.

"The current craze for promoting solar energy could result in ill-assorted, uncoordinated projects which are sometimes completely unsuitable. Therefore, if we do not want to see this technology rejected in future out of disappointment, we should proceed with caution.

"The exploitation of these new forms of energy, especially where they are integral to projects, will require sustained observation, monitoring, analysis and follow-up at operational level.

"The new forms of energy should always be introduced in a context of technology transfer, with the emphasis placed on training, maintenance and project management.

"Since this technology is constantly developing, it is essential that all policy in this sphere should be founded on existing industrial and scientific activities in the developing countries, while at the same time the support of companies in the industrialized world which have already made advances in developing the technology is secured.

"It is essential to set up regional and national organizations in the developing countries whose basic tasks would include the dissemination of information, training, start-up aid for projects, qualification trials, follow-up and industrial promotion if this technology is definitely to take root."

What is true of renewable sources of energy as a whole also applies to photovoltaic energy in particular: the introduction of new technology in the developing countries is desirable only if it meets their needs. The developing countries should not serve as a proving ground for innovation from the old continent.

In October 1981 the Commission of the European Communities held a seven-day international conference at Cannes on photovoltaic energy (the third conference of its kind). The presence of more than 600 delegates from all over the world demonstrated the growing interest of governments, researchers and, above all, industrialists in this new form of energy. In the day's discussion devoted to the use of photovoltaic energy in the developing countries views were exchanged on the very different experiences of countries such as Mexico, India, the Arab countries, the African countries of the Sahel and many others. The conference was organized jointly with the US Department of Energy and the French Solar Energy Commission.

ANNEX

What, in more specific terms, are the lessons which can be drawn from experiments so far with various types of photovoltaic equipment?

Let us take photovoltaic pumps as an example. The following observations have been made from field measurements*of the performance of a dozen such pumps:

- 1) It is very important to choose the best technical approach and plant of the most appropriate size - a choice which must be based on detailed knowledge of:
 - a) the actual well characteristics (flow-rate, dynamic level),
 - b) the solar radiation characteristics of the area in question,
 - c) the effect over time of a tropical environment on the solar cells.
- 2) Very encouraging results have been obtained from simple, directly coupled systems (generator - motor - centrifugal pump). Several units have been operating for two or three years without requiring any attention. Some 90% of failures affected the photovoltaic generator (inadequate protection to begin with, deterioration of certain types of module). Not enough is known yet about module behaviour in a tropical environment (performance drop); later generations of solar cells seem much more reliable.

Very disappointing results have been obtained, however, from indirectly coupled systems, which should in theory give better performance and greater operational flexibility (failure of control units, displacement pumps, belts, etc.).

The use of complex systems must be carefully considered, therefore: conventional solutions in Western countries often prove failure-prone in an African context. As far as the user is concerned, reliability is the main consideration.

Experience also shows that the maintenance and sound operation of these pumps are very dependent on the operational setting and the users' motivation. A contribution to installation costs is an excellent guarantee that the project will "Fit in" well.

In short, simple photovoltaic pumps should soon reach a high level of reliability enabling them to be used on a wide scale.

Although the more complex systems have produced disappointing results so far, they still have potential in the medium term. Before they are introduced in the field, however, there must be extended environmental testing, which it is difficult to perform in test establishments.

Are photovoltaic pumps a cost-effective alternative to diesel ones? The answer is "yes" - in certain cases. It all depends on the costing, which must be approached conservatively and must take into account the specific circumstances in each case. Generally speaking the initial investment for a photovoltaic pumping system is much greater than that for a diesel system of roughly equal capacity (sometimes even twice as great). The diesel

*SEMA studies for the French Solar Energy Commission (COMES) and the European Development Fund.

pump-motor, however, has a shorter life than a photovoltaic pump and, more importantly, gives rise to maintenance and operating costs (diesel fuel) which may amount to the same as annual depreciation. The maintenance costs of a photovoltaic pump are negligible in comparison. Accordingly, in some peoples' opinion the cost per m³ of water pumped by a photovoltaic solar pump - on certain assumptions - is significantly lower than for a diesel pump. Operating costs per m³ of pumped water are also much lower with solar pumps. This comparison of costs does not take into account certain non-quantifiable, but vital, factors: security of supply, village self-sufficiency, socio-cultural impact, etc.

Any comparison of costs which is too general demands great caution for the following reasons:

- a) the two products are at very different stage of development;
- b) life time and the maintenance costs vary considerably between sites;
- c) total capital costs also vary a great deal, depending on the technical configurations chosen and the siting of the pumps;
- d) annual operating times may vary considerably according to climate and requirements.

OTHER PUBLICATIONS RELATED TO 'DEVELOPMENT'

Other EEC publications about the Community's relations with the Third World can be obtained from the following address:

Spokesman's Group and Directorate-General for Information
Publications distribution service, Room 2/84
Commission of the European Communities
Rue de la Loi, 200
B - 1049 Brussels (Belgium)

1. Dossiers

- The European Community and the Third World, Bruxelles, September 1977
- Europe and the Third World
A study on interdependence (by M. Noelke)
- Europe - Third World : The challenge of Interdependence (M. Nölke)
Edition 1980
- Lomé II - Special edition from the 'Courier' n° 58

2. "Information Series" and "Europe Information": (generally all Community languages)

- The European Community and the Textile-Agreements
special edition (June 1978)
- The European Community and the Arab World n° 169/79
- Europe-Tiers Monde: Rural Development
- Solar Energy: A new area of ACP-EEC Cooperation
- The EEC and the developing countries: Outside the Lome Convention and the Southern Mediterranean
- Community Wine Imports
- Lomé II - Analysis chapter by chapter of the EEC-ACP Convention
- The development of trade between the European Community and the Arab League Countries
- Implications for the Southern Mediterranean countries of the second enlargement of the European Community (R. Taylor)
- Implications of the second enlargement for the Mediterranean and "ACP" policies of the European Community (E. Guth)
- The Question of Commodities in the North-South Dialogue