# PHOTOVOLTAIC OUTLOOK FROM EUROPEAN COMMUNITY'S VIEWPOINT

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ABSTRACT

Since 1980 photovoltaics have entered a new development stage in Europe. A powerful European industry has become organized and has set up aggressive investment strategies. Solar cell and panel production has made significant progress in some companies. Cooperation with developing countries, in particular in Africa, has made a good start with photovoltaic water pumps, educational T.V. and the like, thus demonstrating the large potential of PV for new rural electrification schemes.

The Commission of the European Communities together with the governmental authorities in the 10 member countries of the EEC has largely contributed to the current state of progress by the encouragement of industry and by having a comprehensive development programme.

## 1. Introduction

Photovoltaics is currently recognized as a top ranking technology among the new energies. Photovoltaics has the potential to eventually make a sizeable contribution to the power generation capacity in the industrialized and the developing countries, even though this might presently not be admitted by all decision-makers: until now it was not possible to assess any serious obstacle for achieving the cost goals which have been set out for cost-competitive power production on a large scale.

Future development of photovoltaics calls for a joint effort of (1) industry, (2) national and international authorities and (3) universities and other research institutions. Production and costs will depend on what the industry will do; hence industry has the key to photovoltaics. Universities and other research institutions are also important as they provide scientific support to the industry, keep the route for technological alternatives open and support quality control operations. The rôle of the EEC Commission and the national authorities in Europe is at least three-fold:

- through comprehensive research, development and demonstration programmes, take initiatives, provide scientific and technological guidelines, develop mid- and long-term strategies, stimulate and control international cooperation;
- through direct funding and subsidies create the technological and scientific environment for future progress, support the industry by taking up part of their financial risk and providing incentive capital, develop technological alternatives;
- in the frame of national and European energy scenarios, assess the rôle of photovoltaics and provide guidelines for its implementation.

## 2. Historical retrospect

Photovoltaics for terrestrial applications came into focus at the IEEE photovoltaics conference in 1972 at Silver Spring and at the UNESCO conference "Solar Energy in the Service of Mankind" in July 1973 in Paris, i.e. it all started before the first oil price increase in the winter of 1973/74. The photovoltaic industry at that time was involved in space activities and in electronics but had no interest at all in energy matters. It was obvious that this industry had great difficulties moving into the terrestrial business: after all, a silicon chip achieves more than a hundred times the price when it is sold for a satellite generator or integrated circuits than it does for a terrestrial generator.

Hence, there was a need for a new and motivated photovoltaic industry. It is interesting to note that in 1972 the "photovoltaic community" in Europe as in the United States reflected the situation in industry: at that time, most of its members were sceptical about terrestrial developments and were more concerned with trying to shoot holes in the "balloon" rather than giving a hand. This was probably one of the reasons, too, why photovoltaics was critically assessed over and over again, much more than nuclear power or other energy sources had ever been before. When it became clear that photovoltaics do offer technologies in plenty for very low cost, need little space for installation and have reasonable energy pay-back times, one started to look into the environmental

aspects; raised the problem of structure costs and there is no end in sight for those studies.

In 1973, in what we may call the year 0 for terrestrial photovoltaics, Europe and the United States were at the same stage. In the United States, however, pioneers and industry were faster in coping with the new situation. At least, two new companies were already set up in 1973 in the United States, both starting from scratch and concentrating on terrestrial applications. The old ones changed ownership, other new ones followed.

In Europe, industry took more time to adapt itself. Out of the four solar cell companies in the early 70's two retired completely from the field, another merged with a new international company. Only since 1980 has the European photovoltaics industry become clearly motivated and strong; at the present time, more than 10 small, medium or very large companies are involved in solar panel production and development. It can be assumed that the European Communities' photovoltaic pilot programme which is described here below was an opportunity for European industry to develop a better strategy.

Leaving aside the organizational problems in its industry, Europe always maintained its strong interest in photovoltaics and made significant contributions to its development; here, I would just like to mention, as an example, the semi-crystalline silicon cell which was simultaneously developed in Germany and the United States.

## 3. Hard or soft technology

Photovoltaic systems have the potential to become cheap enough for large-scale power production. They have a long life expectancy and virtually no need for maintenance and hence could eventually be employed in large power stations as well as on everybody's roof top. The question for Europe is how, where and when. Applications may be divided into soft or hard technology systems. Soft technology systems are generators on the roof of homes, shopping centres, industrial plants, generators for communities and the like. Hard technology systems would be solar power satellites, multigiga Watt plants in the Sahara desert with electricity or hydrogen transmission to Europe by cables, pipelines or ships and 100 MW or GW plants installed in Europe.

Despite the recent success of the space shuttle and the revival of interest for human colonisation of space, my own opinion is that the power satellite is not a good idea at all, mainly for cost reasons.

The other types of hard technology systems are interesting enough to be seriously considered in European energy strategies. Large photovoltaic central power plants in Europe and in Northern Africa may well have a larger potential to meet a significant part of Europe's energy needs than any other of the new energies, including fusion. It would be timely to develop energy scenarios including those options.

It may be dangerous, however, to concentrate on the hard technology option while neglecting the soft technology approach; both need development on a significant scale. Photovoltaic generators in small units for homes have been assessed as a viable alternative in Europe and should be developed immediately. As a rule, these generators should be grid connected to cope with the storage problem. Hence, utility involvement is needed as much as is the hard technology approach.

By the end of the century a few percent of Europe's energy consumption could be met by photovoltaics in both ways.

In any event, it is difficult to believe that photovoltaics can become nothing more than a large export item for European industry unless photovoltaic plants are installed in Europe itself to a reasonable extent.

## 4. Rôle of the industry

As mentioned before, the situation in Europe's photovoltaic industry has improved dramatically in recent months. For silicon material, a German company is one of the world's leaders in the field. For cells and panels at least ten European companies from 6 countries are involved in production and marketing. More than 30 companies are involved in research and development. A significant number of European companies have set up joint ventures with companies in the United States. At least 6 photovoltaic companies in the EC have US stockholders and at least 3 US companies have EC stockholders.

European industry has set up major investment plans in photovoltaics. In the next few years private investment in the field is most likely to exceed public funding.

The situation is favourable now in view of further cost decreases in photovoltaic cells and panels for two reasons: (1) industrial competition which will be severe and (2) new efforts to install automated industrial production lines. Until now, in Europe - as in the United States - production was largely hand-made and production technology either obsolete and derived from space technology or very recent with the need to be "run in". Hence, up to the present time, "learning curves" in photovoltaics were rather meaningless, but this is bound to change in the near future.

In 1982, European industry forecasts a total panel production of 5 MW.

## 5. Institutional aids

Photovoltaic systems involve high investment cost while fuel and maintenance are virtually free. There is a need in Europe to promote the market by tax credits and leasing schemes.

As most of the systems will be grid connected, favourable buy-back rates for the surplus electricity fed by the photovoltaic generators into the grid have to be negotiated with the utilities. A similar problem has been raised recently in Denmark where private wind generators feed electricity into the grid. There the utility agreed to buy the electricity back at a 50% reduction.

## 6. Research and development

Considerable R+D efforts are still necessary to achieve large-scale, cost-effective production in automated lines. In the next few years, R+D will be implemented in industry to an even larger extent than in the past. Silicon is the leading material in Europe but CdS has also been taken up by industry and there is hope that this will be the case as well for CdSe and amorphous silicon.

R+D needs continuing support also outside industry to keep the way open for alternative materials and processes.

While R+D efforts on cells and modules have so far been sizeable and have already led to significant results, systems are still in an early stage of development. First systems have been put together with priority for export markets in particular, for battery chargers and water pumps. There is room for further improvement regarding efficiency and cost decrease of such systems.

Almost all has still to be done for applications of solar cells in Europe, i.e. on the scale of 1 kW and above. The first European house equipped with solar cells has still to be built; the same holds true for larger plants, e.g. for villages, rural or industrial applications. The photovoltaic pilot programme of the European Communities is aimed at the development of complete systems and some subsystem development in particular for supporting structures, cabling and power conditioning.

## 7. EC photovoltaic pilot projects

Within its solar energy R+D programme, the Commission of the European Communities has set up a photovoltaic pilot programme, in force since 1978. The programme was decided upon by the Council of Ministers of the EEC in the middle of 1979; it is part of a comprehensive photovoltaic R+D effort which includes cells and modules as well.

The photovoltaic pilot programme concerns the development of complete systems. As in a matrix it includes on the one hand, a large variation of photovoltaic technologies and, on the other, various types of utilizers in varying sizes. By assembling 18 individual projects throughout Europe into one coherent programme, it was possible to greatly enhance the benefit for the community and all participating industrial consortia.

The pilot programme includes a total of 1.3 MW split into projects from 5 kW to 300 kW. The Commission bears approximately one-third of the total cost of ≯ 36 million. The rest is funded by national and regional authorities, utilities, industry etc. The programme started in March 1981; final design is scheduled for December 1981. All projects will be installed by mid-1983. Table 1 provides a summary of projects :

TABLE 1

COMMISSION OF THE EUROPEAN COMMUNITIES' SOLAR ENERGY R+D PROGRAMME

PV PILOT PROJECTS

| Peak power in kW | Site | Application |
|---|---|---|
| 300 | Island of Pellworm (Germany, FR) | Power supply for a vacation centre (Kurhaus) |
| 100 | Vester Boegebjerg near Korsoer (Denmark) | Power supply to a village |
| 100 | Kythnos Island (Greece) | Power supply to a village |
| 80 | Alicudi Island (Italy) | Electrification of an island (120 inhabitants) |
| 80 | Marchwood near Southampton (United Kingdom) | Power supply to the grid |
| 70 | Verona (Italy) | Fresh water pumping |
| 65 | Tremiti Islands (Italy) | Water desalination |
| 63 | Chevetogne (Belgium) | Power for solar heated swimming-pool |
| 60 | Réunion Island, Indian Ocean (France) | Power supply to a remote village |
| 50 | Montpellier (France) | Power supply TV transmitter of Télédiffusion de France |
| 50 | Nice (France) | Nice airport power management and control |
| 50 | Fota Island, near Cork (Ireland) | Electricity for a dairy farm |
| 50 | Terschelling Island (Netherlands) | Power supply to a marine training school |
| 50 | Crete Island (Greece) | Electrification of a remote village |
| 45 | Giglio Island (Italy) | Water disinfection, agricultural coldstore |
| 44 | Rondulinu Cargese, Corsica (France) | Power supply to dwellings, a dairy and a workshop, water pumping |
| 30 | Hoboken (Belgium) | Hydrogen production and water pumping in industry |

Table 2 gives a description of the project to be installed in Sicily; it includes eight 5 kW projects, the size which may be used later in photovoltaic houses in Europe.

TABLE 2

COMMISSION OF THE EUROPEAN COMMUNITIES' SOLAR ENERGY R+D PROGRAMME

PV PILOT PROJECTS

The Eighteenth Project

Site : Sicily, next to 1 MW tower power plant EURELIOS
8 systems connected to the national Italian network of ENEL

Flat-plate arrays

5 kW fixed mounted silicon (Italian product)
5 kW fixed mounted CdS, evaporated (German product)
5 kW fixed mounted CdS, sprayed (French/US product)
5 kW silicon array, sun tracked (identical array is installed at Pellworm (Germany)) (German product)

Concentrators

5 kW paraboloidal, total energy system (French product)
5 kW parabolic trough (Italian product)
5 kW circular Fresnel lenses, plastic (French product)
5 kW circular Fresnel lenses, glass (Italian product)

(1) The opinions expressed in this paper are not necessarily those of the Commission of the European Communities.