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Final Report on the Charmey Workshop (Part II):

Outcome of Brainstorming Sessions

This part contains the results of the brainstorming sessions which were held after the introductory lectures. The topics of the sessions were identical to those of the lectures, i.e. Electricity Generation, Fuels and Chemicals, Materials and Processes. All sessions dealing with the same topic were prepared, conducted, and evaluated by the same crew, consisting of a technical team of two experts and a moderator. The reports on the outcoming of the brainstorming sessions have been written by these technical teams.

Electricity Generation

Harold M. Hubbard and Jean-Claude Courvoisier***

1. Introduction

Electricity was appropriately designated by the Conference organizing Committee as one of the three subjects for special attention in as much as it is the one energy form whose use continues to correlate directly with economic growth in the developed countries, and it is essential to the development of modern communication and health delivery systems in the Third World. Also many solar technologies, notably photovoltaics (PV), wind turbines, solar thermal electricity generation, biomass combustion, ocean thermal systems, geothermal systems, and hydroelectric power, are well adapted to electric power production over a wide range of scale and end use conditions. A large base of scientific knowledge and practical experience has been accumulated in support of these alternative power sources. Nevertheless, the world has been slow to put them into practice, because of relatively high initial costs, questions about reliability, compatibility with current power distribution systems, and a general lack of familiarity with and hence distrust of these new power sources on the part of decision makers.

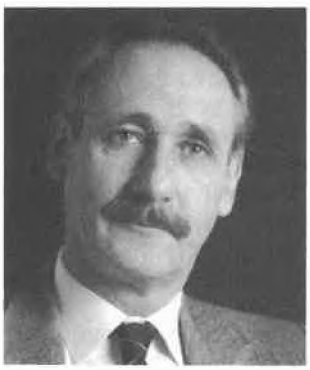
In the plenary session the current state of the art for PV, solar thermal and wind electricity generating systems was reviewed primarily from the point of view of potential large-scale applications. After the review three brainstorming sessions were held with attendees at the conference with 10 to 12 different individuals attending each session. The technical team (*Hubbard* and *Courvoisier*) acted as recorders and the moderator (*Bisang*) managed the sessions. Participants were encouraged to bring up any ideas they carried and a spirited, free flowing discussion resulted.

The technical team recorded the suggestions as they were stated and subsequently consolidated the three lists from the various sessions into one, presented in section 3 as the compiled output from brainstorming sessions.

Since it was not possible to discuss all of the suggestions at the conference, the technical team reviewed the suggestions and from them developed a list of topics for the discussion groups to consider. This list is presented in the next section.

2. Topics for Group Discussion

- *Photovoltaics* (does not include photoelectrochemical cells):
  - Fundamental study of the influence of the microstructure and composition on photoelectric properties aimed at identifying promising new PV materials.
  - Study biological systems as possible models for bio-compatible inexpensive photoconversion systems, leading to both PV and light-storage applications.
- *High-Temperature Electricity Generation:*
  - Improve absorptivity of thermal receivers.
  - Develop low-cost polymeric reflective materials with optimized optical properties.
- *Wind Energy:*
  - Develop a better understanding of the dynamic interaction between structural loading and systems optimization with the objective of improved design tools.
  - Consider the possibility of high-altitude wind streams as an energy source.
- *High-Temperature Superconductivity (HTSC):*
  - Study the impact of the development of practical HTSC materials on energy generation, storage, and distribution systems.



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3. Compiled Suggestions from Brainstorming

Topical Areas for Research Attention

- Study photoluminescent phenomena for light-storage purposes.
- Semiconducting organic polymers to be used in photovoltaic cells.
- Investigate biological systems that produce electricity (e.g. the electric eel) as models for practical systems.
- Investigate naturally occuring photosensitive materials.
- Theoretical investigation of microstructure to identify new promising materials as candidates for photocells.

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** With regard to this author see also p. 197.

- Study of possible impact of breakthrough in high-temperature superconductivity on solar energy systems.
- Investigate the various ways of using ocean gradients (arctic thermal, salt concentration etc.).

Specific Ideas

- Develop a solid-state photorechargeable battery.
- Develop a cell based on the variation of dielectric properties under temperature gradient.
- Use thermal pressure to activate a piezoelectric device.
- Develop a photovoltaic material to be used as paint for large-area low-cost PV installations.
- Develop throw-away biocompatible PV cell materials.
- Influence the structure of semiconductor thin films by appropriate epitaxy methods.
- Consider parametric systems for photon conversion.
- Develop large-area light collectors coupled with light pipes both for area lighting and photovoltaic cell concentration.
- Develop static light concentrators (5–10 times) for bifacial solar cells.
- Develop cheap disposable reflective films.
- Improve the absorptivity of thermal receivers.
- Combine wave and/or wind power with hydroelectric power.
- Study wind concentrator (shroud) for wind turbines.
- Study the possible use of wind turbines attached to balloons for exploiting high-altitude jet streams.
- Investigate natural electricity generation processes in order to find out a way for exploiting solar generated convection (thunderstorm).

General Suggestions and Comments

- Problem of integration of systems into the grid versus dispersed systems will favour renewable energy provided the storage problem finds a satisfactory solution.
- Use of telephone system to match phase of individual producers with the grid.
- Low-intensity power applications should be stressed as possibilities for solar electric utilization.
- Consider the extensive applications of solar systems from the viewpoint of their impact on the change in albedo.
- One should look for unexpected by-product (i.e. spin-off) applications of solar technologies.
- Stress importance of systems reliability in developing solar technology R&D programs.
- Make wise use of microelectronics in the design of systems.
- Consider use of ocean currents as an energy source.
- Note that good international collaboration exists in the field of thermal electricity generation but too little in photovoltaics.
- Criteria are needed by government decision makers to evaluate the pros and cons of alternative energy technologies.
- Create an international energy bank to ensure a fair competitive investment capital source for solar applications.

Remarks

One notices from the above list of subjects that the centre of gravity of concern about photovoltaics no longer centres on improvement of efficiency at the laboratory level. Great emphasis is put on cheaper materials, reliability, and coupling with actual electricity distribution systems. One now tries to conceive and develop larger-area static panels with an efficiency not less than 10% which could as well be decentralized and autonomous or connected with the grid.

The environmental impact of any conversion system becomes an overall concern for the scientists. Biocompatible, biodegradable materials as well as albedo changes are among the parameters which need to be seriously taken into consideration.

Thermal electricity generation is not seen to be a major item for long-range research opportunities among the participants. However, cheaper mirror materials and better absorptive and stable layers are needed.

There is still generation of «exotic» new solutions to solar electricity production (piezoelectric, dielectric, parametric etc.). In spite of the fact that many of the speculative ideas proposed in the workshop finally turned out to be impractical, one should never rule out the possibility of finding a really novel and potentially valuable new way of utilizing solar energy.

The natural phenomena which involve huge energy quantities arising from solar flux are as yet hardly exploited, with the exception of hydroelectricity. Several ideas were expressed related to ocean (concentration gradients, thermal gradients, currents, waves) or to the atmosphere (high-altitude jet streams, thunderstorms etc.).

Wind energy appears as a very valuable source of electric energy. It is worthwhile now to envisage a strong effort from the engineering viewpoint in order to bring this application to an economic, competitive energy production process.