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Arguments and necessary strategies for the implementation of solar energy technologies

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Abstract : A summary of arguments is given which can be raised in favour of a more determined development of solar energy technologies. In addition, a list of measures is discussed which are needed to prepare their route for implementation.

The development of solar energy technologies is widely supported by public opinion but for various reasons it appears to be difficult to provide them with a sufficient thrust in direction of a significant contribution to our energy supply. Why is it necessary to support solar energy development with complementary measures ? The following are some key arguments.

Arguments in support of a large scale implementation of solar energy technologies :

. **The availability argument** : Solar energy is a renewable energy which provides approximately ten thousand times the energy needed for supplying mankind with energy. For comparison : the entire energy gain to be expected from a full scale worldwide nuclear breeder energy technology does not exceed the solar energy incident on earth during eight days.

. **The environmental compatibility argument** : Solar energy conversion is widely practiced in photosynthesis and considered the basis of life on earth. A solar hydrogen economy will just be a technical variation in which hydrogen will be handled as a gas and not chemically bound to other molecules. Solar energy has the potential of being entirely compatible with the environment.

. **The efficiency argument** : It is a generally observed rule that energy conversion efficiencies of newly developed technologies start at comparatively low values but over decades of technical development gradually increase to approach the limits given by the known laws of physics (examples : efficiency of electrical power stations, energy consumption of refrigerators, fueld consumption by cars, efficiency of airplanes, output of lasers). The theoretical efficiency limit of solar energy conversion into electricity, for example, when several materials cooperate, is exceeding 60 %. Solar cells made by one material (silicon) already reach an efficiency of 23 %. It can be expected that the efficiency of commercially available solar cells (at present approximately 10 %) will, at the long term, increase three- to fourfold. Similar arguments apply for other solar energy technologies.

. **An argument from evolution** : Biological evolution has strongly favoured energy and materials saving as well as recycling while relying on the inexhaustible regenerative solar energy source. There is still a large potential for energy and materials saving in solar energy technology. One example : nature is producing the solar energy converting membranes in plants at ambient temperature while the materials used in our solar cells (silicon, glass, aluminum) require processing at very high temperatures. Natural energy converting membranes are also ten thousand times thinner than our present solar cells. Since the laws of physics are the same for nature and technology there is a long term potential for technical and economic improvement of solar energy systems.

By excessively using nonregenerative fuels and aiming at satisfying the ever increasing energy and materials demand instead of emphasising strategies to save them, mankind will face mounting problems with the environment and finally seriously threaten its basis of life.

. **The responsibility for developing nations** : Developing nations, which account for most of the world's population growth, usually insist in implementing, in their countires, those technologies, which already have demonstrated practicability and are employed by industrialised nations themselves. Since a massive use of fossil fuel of nuclear energy by an estimated world population of more than ten billion can not be easily tolerated for environmental reasons, technically mature and economically acceptable solar energy alternatives are urgently required.

. **The land use argument** : The consumption of land for solar energy use, often claimed to be excessive, will be smaller than the area already wasted worldwide by nuclear activities (military and peaceful, nuclear accidents) in less than half a century. It will be less than one percent of the earth surface and thus comparable to the percentage of land occupied by buildings in industrial countries. At a long term solar cells will be an integral part of buildings and additional land consumption for solar energy will be limited.

. **The long term synergetic effect** : Solar energy technology involves a wide spectrum of scientific and technical disciplines which have to be developed simultaneously. Significant cost reduction and high efficiency can only be expected when all these technologies have reached a certain maturity. Self sufficient solar energy houses, for examples, which are presently developed, require photovoltaics, as well as thermal heating, transparent insulation, hydrogen production by electrolysis, hydrogen storage and electricity production by fuel cells. They also need electrical installations optimised for energy saving. Most of these complicated technologies are insufficiently developed and need major support. Their collective function cannot be expected to be optimised and economic at a very early stage, especially since no mass production of the components is practiced. With respect to scientific challenge and technical complications there is no justification for supporting development of solar energy technologies much less than development of nuclear energy and fusion.

Recommended actions to accelerate development of solar energy technologies :

. **Establishing real energy costs** : To give solar energy technologies a real chance, it is necessary to charge the real costs for all other present energy sources (including real social costs, costs of worldwide pollution, costs for safeguarding international supply, costs for research and development, costs for transport, insurance against accidents, costs for waste disposal, costs for future generations).

. **Charging a tax for carbon dioxide emission** : Because of its cumulative effect on the greenhouse phenomenon the emission of carbon dioxide should be taxed. The tax could be low at the beginning but should raise as environmental conditions deteriorate.

. **Establishing an International Solar Energy Agency (ISEA)**. It should have a similar task for the implementation of solar energy as the International Atomic Energy Agency for nuclear energy (excepting the task for preventing nuclear proliferation).

. **Funding the ISEA with carbon dioxide tax money** : The money charged for carbon dioxide emission can be recovered by the paying countries with suitable research or development projects on energy saving or solar energy utilisation. An important effect will be the creation of a long term market for solar energy technology which will stimulate industrial efforts.

. **Supporting legislation for a stepwise application of solar energy**. New buildings should, for example, recover a certain percentage of electricity and heat from solar energy.

. **Helping solar energy research and development to become independent from competing interests** : Sociology of science has learned that established schools are never able to support a school with a different philosophy. It is a mistake to give nuclear research installations a major responsibility for solar research and development without warranty for a strict separation of competence and responsibility. Complications of this type have happened in most European countries.

. **Providing public relations funds for solar energy**, which are comparable to those spent by the nuclear and fossil fuel industry and collaborating institutions and establishing visitor centers for the demonstration of solar technologies.

. **Making solar energy more attrative for science.** The funding and social prestige of researchers working on solar energy problems should be improved to attract more interest and stimulate more creativity. There are no objective reasons, besides of those mentioned, which could explain why, for example, superconduction research has attracted considerably more materials scientists than photovoltaic research.