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World Solar Summit
Sommet solaire mondial

Solar Energy - A Peaceful Energy

Energie Solaire - Energie de la Paix

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WORLD SOLAR SUMMIT

Solar Energy - A Peaceful Energy

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Solar energy - A Peaceful Energy

Energie solaire - Energie de la paix

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1. Introduction (UF)

Solar energy, and more generally renewable energies, are widely perceived as peaceful forms of energy, as compared with other energy sources. Nuclear energy made its first public appearance at Hiroshima, and this fact still weighs heavily on its public image, no matter how distinct and remote its peaceful applications may be from its original military use. Oil is immediately linked with the tensions of the seventies and the Gulf War: and struggles for the control of the richest oil fields and for assurance of supply are indeed not just a remembrance of the past. Coal is widely perceived as a threat to the environment and global climate.

Solar energy, unlike nuclear and chemical energies or biotechnologies, does not lend itself to offensive applications. Even the legendary use of mirrors to concentrate solar rays on the enemy ships attibuted to Archimedes seems to have little historical and scientific foundation.

A part of the peaceful connotation of solar energy with the public may have cultural roots dating way back in the past, as will be pointed out by Barbara Ischinger in the third section: and this is substantiated today, as she clearly shows, by the fact that its primary source, the Sun, is out of the reach of human control and litigation, by its ubiquitous (if not uniformly distributed) presence in all countries, and especially by its sparse nature, which make a control at the community level both possible and necessary, thus calling for a basic democracy which is the true guarantee of peace.

Among the conflicts which can potentially derive from the use of conventional energy sources, and which will be reviewed in the next section, of particular importance are those connected with the scarcity of water, the origin of many acute conflicts in the past and which may as well play a destructive role in the future, especially in the arid countries of the Middle East, which are at the same time the repositories of the largest and cheapest reserves of oil, the most commonly used source of energy today. Harry Tabor will discuss this problematique in the fourth section, and he will show how solar energy may contribute an effective solution to the problem of scarcity of water and be turned into a powerful instrument for peace in the region.

Trying to wrap up these contributions in the conclusions of the last section, we shall put forward the hypothesys that renewable energies can indeed play an important role in assuring peace for the future generations; and that this role should not be seen simply as that of providing to all countries the means of energy self-sufficiency, thus eliminating the struggle for the control of finite, non-renewable energy sources; and of not creating conflicts for the protection of the environment, another finite and (at least partially) non-renewable resource. Renewable energies should also be the occasion of broad and deep international collaborations, putting in common natural and human resources, technology and capital. Only by creating n w positive, constructive and mutually convenient links among countries can the peaceful potential of solar energy be fully exploited.

2. Energy as a source of conflicts (UF)

This section is partially based on ref. /1/.

Until about 100 years ago, energy was a local business. The use of wood and agricultural residues was limited to the immediate surroundings of their source; the same applied to the exploitation of wind and running water. Even coal (the motor of the industrial revolution) was generally not transported over long distances, and industrial centres grew close to coal deposits. Up to 1950, only a small part of fuels was traded on the international market.

It was only with the post-war industrial boom, when oil became the leading energy source, that a substantial and increasing part of the energy used around the world originated in countries other than those where it was consumed. This was due first of all to the easy mobility of oil and its products (by means of tankers and of pipelines); however, the international movement of coal and especially natural gas also increased substantially in the last two decades. Even electricity, despite the difficulty and cost of dispatching it over long distances, is becoming more and more a commodity sold on the international market. Progress in

transport technologies for all energy vectors (such as for instance the development of superconducting transmission lines or of the coal-water slurries) as well as the development of new energy vectors (notably hydrogen, but possibly also ethanol and methanol) are likely to increase the mobility of energy sources.

Although fossil fuels are a finite resource, non renewable in terms of the human time-scale, we are still far from their physical exhaustion. Actually, proven reserves of oil, natural gas and coal are greater today than they have ever been, new deposits being found or known reserves upgraded at a pace faster than that of consumption. However, reserves in the Middle East have extraction costs which are much lower than those of other deposits and can therefore dictate to a large extent the price of oil on the international market. The two oil crises of 1973 and 1979-1980, with the consequent world-wide economic depression, and the countershock of 1985 have shown how the rigidity that affects both demand and supply can bring to instabilities in the market. Only a much greater flexibility in energy sources, which allows for a rapid substitution of one fuel with another, or a long-term agreement on availability and prices between producing and consuming countries (which is in contrast with free market principles) could shield the world from further energy crises which are difficult to predict and whose consequences may be very negative for the economy. As long as this does not happen, the assurance of availability and the control over the price of oil are going to determine international tensions which may (as we have recently seen) create the conditions for war.

Natural gas is more difficult to transport and store than oil; however, its share in the world energy budget has been steadily increasing to the present 20%, due to its superior environmental qualities and to a relative stability of prices. The largest share of gas transport is by means of pipelines, which connect to day Eastern and Western Europe, Northern and Southern Europe, North Africa with Western Europe, Canada with the United States. Gas pipelines constitute permanent links, requiring large investments, between two countries or two groups of countries. This fact may have both negative and positive consequences: negative, because it creates a rigidity that may be used for pressures (either way); positive, because it constitutes a bridge uniting the destinies of two countries, both of which gain from its existence. When the transport of natural gas is carried out by mean of liquefaction, special tankers and regassification, the infrastructures are expensive, but the system becomes more flexible, since both exporters and importers can be changed, provided they have the necessary installations.

Oil and gas pipelines passing through intermediate countries are subject to interruptions by these countries for political or economic reasons; this has happened or has been threatened several times in the recent past, for instance by countries of the former Soviet Union. This is another cause of tensions that may eventually generate open conflicts.

Nuclear energy poses no problem, at least for the time being, as far as its primary energy source is concerned. Uranium is abundant and present in many different countries; its price is steadily declining in the international market, and in any case its influence on the final cost of the kWh generated is too small to create problems. What is not readily accessible for nuclear energy are the technologies and the special services which are needed. Few countries possess them; their diffusion meets barriers not so much for technical and economic reasons as for the preoccupations for nuclear proliferation: that is, the possibility that through the utilisation of nuclear technologies meant for civilian applications, more countries can acquire the capability of designing and constructing nuclear weapons. Peaceful nuclear energy is not the only way (and probably not the easiest way) of acquiring the strategic materials needed to build a bomb (such as plutonium and highly enriched uranium). The secret military nuclear programme unveiled in Iraq after the Gulf war was practically independent of its alleged peaceful programme. However, it is quite true that the last could be used as a shield to acquire some pieces of equipment necessary for the first; and that much generic know-how having to do, for instance, with handling radioactive materials is common to both. The uncertainty of what should be classified as "sensitive technology", and the existence of dual-use technologies, has curtailed in the past (and still does in the present) the free flow and transfer of nuclear technologies, of nuclear materials, components and installations from one country to another. In turn, these restrictions have in many instances generated international tensions. On the recipients' side, such restrictions have concerned (in addition to Iraq) India, Pakistan, South Africa, Iran, Israel, Argentina and North Korea.

Environmental change has recently been identified as a source of violent conflicts /2/. Energy-related environmental aspects are among the most critical issues in generating potential tensions and conflicts. Here again there has been a very evident process of internationalisation and globalisation. While in the past pollution was mostly a local phenomenon, transnational effects have gradually come to the fore. Acid rains, deriving from the release of sulphur and nitrogen oxides in the combustion of fossil fuel (particularly

coal), occur many hundred kilometres away from the polluting source, often in a different country, and have adverse effects on agriculture, on forests, on lakes and on the conservation of manufacts and works of art. This has been the cause of considerable controversy between Canada and the United States; between Scandinavian states and the United Kingdom, between Central and Eastern Europe. Similar problems are likely to occur in the future between China and its neighbours. The reduction of emissions is technically possible but economically expensive, and affects subjects which are different from those suffering the consequences of acid precipitations; there is thus ample potential for international litigation. Oil spills from tankers are often cause of major ecological disasters which involve countries different from those of origin and of destination of the oil.

Nuclear accidents can have radiological consequences easily crossing national borders, as was clearly demonstrated by the Chernobyl disaster. Although international conventions exist, or are being negotiated, to provide transnational coverage for the refund of damages, both geographical extension of these conventions and the maximum amount of damage covered are far below what would be necessary for accidents as serious as that of Chernobyl.

The most difficult case, however, turns out to be the threat to the stability of global climate deriving from the greenhouse effect, in particular as a consequence of the use of fossil fuels. The amount, timing and consequences of this effect (and to a certain extent even its reality) are subject to important uncertainties and controversy. It would affect different countries in a very different way, and people in some countries sometime even regard it as potentially positive (although this is probably a misconception, at least for a long transient period). The actions needed to prevent or delay it would have very different costs and impacts in the various countries, and could be practically unbearable by the poorer countries on their way to development. On the other hand, only an action at the global level to curb emissions of carbon dioxide could be successful. An agreement on the principles to be followed to share the burden among the countries is extremely difficult to find and subject to highly controversial dispute, as was shown by the discussions and negotiations centred around the United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992. If further evidence of greenhouse warming will be apparent in the future, and preoccupations on its consequences will grow in industrialised countries, thereby increasing international tension. Although it seems unlikely today that such tensions may directly lead to conflicts, they could play an important role as one of the causes of the impending North-South confrontation, which could replace the East-West confrontation which has just disappeared.

3. Aspects culturels de l'énergie solaire (B.I.)

Le soleil a subi, depuis au moins cinq millénaires, un processus contradictoire de désacralisations successives. Ces desacralisations scandent l'histoire de l'humanité depuis la formation des premières civilisations dans un mouvement qui, tout en mettant le soleil à sa veritable place grâce au développement des sciences, ne l'a pas totalement désinvesti de ses fonctions symbolyques. Ces fonctions, qui restent opérantes dans certaines pratiques rituelles chez diverses communautés, sont la plupart du temps à l'oeuvre, de façon latente, dans différents domaine dont celui des énergies renouvelables.

C'est ainsi que le soleil, ayant été un des éléments fondamentaux des mythologies codifiées et des systèmes de valeurs symboliques de toutes les communautés humaines, apparait aujourd'hui dans les débats sur les énergies renouvelables, certes comme la source d'une énergie connue, contrôlable, mais aussi investi, dans une perspective qui reste pour le moment essentiellement technologique (et, par conséquent, comme l'histoire de la technologie nous l'a souvent appris, non dénuée de tout romantisme) d'une nouvelle fonction hautement symbolique dans l'interdépendance reconnue et réfléchie de l'homme et de son environnement, au sens le plus large du terme.

En effet, selon certains, l'énergie solaire - par le fait que sa source, le soleil, reste inaccessible aux rapports de pouvoir entre communautés humaines - se profile depuis les premières tentatives de sa captation, comme une dernière possibilité pour l'homme de résoudre de façon pacifique la question de l'accès aux sources énergétiques, à l'origine de si nombreux conflits.

A un moment où les études prospectives sur de futures "guerres de l'eau" se multiplient, en particulier en ce qui concerne la situation critique au Moyen-Orient, il est sans doute urgent de déterminer si l'énergie solaire, de par sa nature même telle qu'elle a été définie plus haut, peut, dans les faits, accomplir la promesse que d'aucuns, de façon abstraite, voient en elle. Si on prend en compte le fait que depuis plus de vingt ans, les efforts pour capter directement le rayonnement solaire en vue de le convertir en formes d'énergie directement utilisable ont buté sur les impératifs économiques, technologiques et politiques de la competitivité immédiate, et si on ajoute à cela que l'application étendue des technologies de captation

reste limitée à des zones très restreintes, on peut douter que les modalités utilisées jusqu'à aujourd'hui pour faire valoir le potentiel pacifique de l'énergie solaire, soient efficaces sinon réalistes.

Cela dit, les nouvelles stratégies de développement, fondées sur une reconnaisance de l'importance cruciale du facteur culturel, ouvrent une voie plus sûre pour assurer un essor capital à l'énergie solaire. Cette voie est déjà balisée en partie, notamment en ce qui concerne le rôle-clé qu'assurent de plus en plus les communautés concernées par le developpement. C'est a ce niveau, celui de la participation des communautés dans la définition des choix à opérer en matière de développement en général et, en particulier, en matière d'utilisation de nouvelles formes d'énergies, que réside l'avenir même de l'énergie solaire. C'est ainsi, et seulement ainsi, que l'énergie solaire ne sera pas conçue comme un de ces transferts de technologie désastreux qui jalonnent l'histoire des stratégies de développement depuis un quart de siècle. La prise en compte du fait culturel, qui s'identifie à plusieurs niveaux avec la participation, pourra dégager l'énergie solaire des méandres dans lesquels elle a été placée par une conception technologique étroite, qui écarte systématiquement les véritables intérêts des communautés concernées.

C'est la condition *sine qua non* également pour que l'énergie solaire devienne un facteur de paix, même si elle doit rester étroitement liée, par divers facteurs, à l'évolution de l'utilisation d'autres sources d'énergie. A cet égard, la relation entre l'énergie solaire et les conflits qui peuvent éclater autour de l'eau dans certaines régions du monde doit être approfondie, non seulement du point de vue géopolitique, comme cela a été le cas jusqu'à aujourd'hui, mais aussi du point de vue des communautés directement concernées, seule garantie d'une véritable perspective de paix.

Pour assurer une meilleure compréhension de la part des communautés quant à l'utilité de l'énergie solaire, le facteur culturel doit opérer au niveau de leur participation dans le processus du choix de la technologie. Les modalités de cette participation dépendent, en effet, de nombreux facteurs culturels qui déterminent surtout leurs rapports traditionnels à leur environnement. Le défi consiste à articuler ces facteurs avec l'introduction d'une technologie de pointe. A cet égard, il faut insister sur le fait que l'application des technologies actuelles de captation de l'énergie solaire doit être modulée selon les capacités des communautés à les gérer elles-mêmes. Un grand effort doit être ainsi fait tant au niveau de l'explication raisonnée des bienfaits de l'utilisation de cette technologie qu'à celui de l'élaboration d'unités de captation qui puissent être gérées par les communautés elles-mêmes.

4. Solar energy and peace (H.T.)

The following section reports the text of a lecture at the World Renewable Energy Congress, Reading, September 1990 /3/.

War, whether between individuals, families, tribes, dynasties, nations or empires would seem to be an inevitable fact of life, covering the whole of recorded history. In ancient China, 6000 years ago, to be a warrior was an honor, a tradition continuing several millennia. When I was at school in England, the history taught was predominantly European - starting with the Greek and Roman empires - and appeared as a catalogue of wars, some lasting a hundred years - as that between England and France in the 14th-15th centuries - others of shorter duration, such as the 30 year war in the 17th century and finally culminating in a most vicious and devasting First World War, 1914 -1918. And the classrooms of the Western World did not teach how to avoid a Second World War.

Since the present thesis is on peace, not war, this analysis of the causes of war will, of necessity, be very superficial but even so may help us to see the factors that could reduce the risk of - if not eliminate entirely - future wars.

The causes of war can be divided crudely into two: Cause A, pride plus, and Cause B. economic. Cause A. Pride, which is a belief in one's superiority or merit, applies to individuals, to families, dynasties and nations and is the most visible cause of squabbles on a small scale and wars on a large scale. The "plus" included in this class, are other factors such as philosophical, psychological, religious, ideological i.e., non-economic factors. However, history shows that the victors in allegedly purely ideological or religious wars were not adverse to claiming large reparations - gold, silver, slaves and land - from the vanquished! Cause B. The economic causes of war have often been intentionally masked by high sounding ideological or religious claims. Karl Marx believed that all wars were economic arising from capitalistic exploitation and its resultant class differences and that once universal socialism was achieved, there would be no more wars He seems to have been unaware of Cause A - or the possibility that there may be more than one definition of socialism - which very nearly brought the two largest communist countries into military confrontation in 1959.

To eliminate entirely wars arising from Cause A may never be fully achieved, particularly on the small scale, where the psychology of people - their inner need to assert themselves- is basic. But on the large scale, the situation has greatly improved in

the last century and a half. With the ending of the Civil War in America in 1865 and the fact that the United States and Canada have had enough sense to resolve their disagreement by negotiation rather than by war, the North American Continent - representing 15% of the world's land surface area - has been at internal peace - and likely to remain so. The Federation of States we call Australia - representing another 5% of the world's land area - has been at internal peace since its original colonization by the British crown. Europe, aside from the Eastern Bloc, has learned from history - and in particular from two devasting world wars - so that countries that had been at loggerheads since Roman times are now united in the European Community, with a future war between them very unlikely. We have witnessed, in the recent past, the winds of change in the Eastern Bloc that might extend the European peace area to cover the entire continent. The South American, African and Asian continents still have a long way to go for assured peace, since many dictatorships still exist - and a dictator can more easily declare war than the leader of a democratic state in these days of mass-media. As these dictators fall and are replaced by democratic governments, Cause A wars will become less likely, though Cause B wars can still erupt.

A second factor tending to reduce the likelihood of wars between nations is the escalating costs of modern warfare which can destroy the economies of the contestants even before the first shot is fired. Have no lessons been learned from the senseless seven-year war between Iran and Iraq (both dictatorships), costing billions of dollars and close to a million casualties on each side?

There being no magic wand for changing human nature, I will concentrate on Cause B and what modern science and technology can do to eliminate Cause B wars - or reduce the likelihood of their occurrence.

Most of you know that I come from a not very peaceful region of the world but I am not going to discuss politics nor is it my intention to espouse the cause of any particular group in the region but rather the cause of all the peoples in the area. And thisregion is here chosen to illustrate the thesis of solar energy and peace - that applies to many other areas - because of its 4,000-year continuous recorded history.

Going back in time some 3000 - 4000 years, the Bible provides much evidence of the economic causes of wars of that period. When I was a boy, the practice of regular reading of the Bible, not only in church or synagogue, but also in the home, was widespread in Europe and other Christian countries. This custom has greatly diminished in the last hundred years and many young people today have only a sketchy acquaintance with the Bible - or none at all. If one wants to get a clear picture of the economic causes of war in early times, the reading of the Book of Genesis is strongly recommended - and no religious faith is involved.

In Chapter 12 we read that "there was famine in the land and Abraham (the patriarch of the three major western religions) went down into Egypt". This is one of the first descriptions of migration of people in search of water and arable land.

In Chapter 13, we read that Abraham left Egypt and settled in Beth-El. Meanwhile, the tribe had grown in size "and the land was not able to support them .... And there was strife between the herdsmen of Abraham and those of Lot (Abraham's nephew)". This is an example of a war for economic reasons, narrowly averted in this case by Abraham's diplomacy in getting each side to settle in a different area. A second example follows (Chapter 21). "And Abraham reproved Abimelech because of a well of water which Abimelech's servants had violently taken away": what we would today call a "sulcha" (a meeting declaring peace) was arranged, the two sides swore an oath not to fight any more, and they named the place Beersheba (which means the "well of the oath") - and where today stands the Ben-Gurion University of the Negev, whose first departments were dedicated to the study of how to deal with the inhospitable conditions of desert areas. Another example appears a generation later (Chapter 26) where Isaac, Abraham's son, moved his clan to Gerar where, in due course, there were again fights over wells: these were finally settled - and they called the place Rehovot (where now stands the Weizman Institute of Science) which means "room" because "the Lord had made room for them so they could be fruitful in the land".

Thus the early economic wars were fought over water supplies - which may be translated into food-supplies. They were not fought over energy sources, of which there was little need: there was enough wood for the small populations at the time. But in due course and with population growth - wood supplies in some areas became insufficient. Thus the Romans in their capital - with relatively large consumption of fuel for baths and house heating - had to import wood from Turkey and we may assume that the Roman armies assured this supply! Even today, I have personally seen the migration of entire African villages from areas where they have exhausted the natural wood supplies to areas where forests still exist.

It is generally accepted that, despite the population explosion, the world is capable of producing all the food needed but, either for political or monetary reasons, this food is not distributed to all who need it, leaving large numbers of people undernourished. Thus, if we wish to avoid

wars between the "haves" and the "have-nots" (sometimes referred to as the North-South confrontation), we must either improve the distribution process or, in cases where this is not feasible, promote local food production In either case, energy is needed, in the first case to "fuel" the distribution process, in the second, for the food production process itself. This will almost certainly require additional water supplies, again predominantly a question of energy - for pumping over long distances or for desalination.

We should recognize that some economic wars for land have been for what lies - or is believed to lie - *under* the ground, i.e., minerals, gold, silver, diamonds and, in the last 100 years, petroleum and very recently uranium, the latter two commodities being needed for the ever-increasing appetite, in the developed world, for energy sources. Like the food problem discussed above, here again there is a question of uneven distribution: were the distribution of fossil and nuclear fuel deposits to correspond to that of the energy consuming public, clearly there would be no need for wars on *this* account.

Returning to the subject of potable water, in the Western World, fresh water flowing freely from a faucet is taken for granted (as is electricity from a wall socket): the annual cost to a householder of such an essential commodity is low - perhaps a few percent of annual income - and we have become so used to this low cost that, when the "privatization" of water supplies in the U.K. was discussed, the newspaper headlines screamed "Water prices to soar - by £12 ($20) a year per family!" It is thus not surprising that the Western World is simply not adequately cognizant of the problem of potable water in the developing world - and of the tensions that non-availability in a given area can create.

I indicated that I would start with the case of my own area - the Middle East - and gave a few examples from the Bible on clashes over potable water supplies.

If we consider Israel and Jordan today, much of their water for agriculture comes from the Jordan River which is fed from the Syrian hills, passing through Lebanon. Quarrels between Israel and Jordan on the division of these waters have already surfaced - and was a partial reason for the Israel-Arab war of 1967: by the end of the century, Israel's needs may exceed supply by 30% and Jordan's need by 20%. Both Israel and Jordan would have reason to worry should Syria alter the flow of the Yarmuk river that provides irrigation water to both countries.

The Nile river originating in Ethiopia, provides water for Egypt. But the population explosion in that country (expected to double to 110 million in the next 25 years) will render the Nile river inadequate - and African countries upstream of the Nile will also find the same. One can well imagine the worry to the Egyptians at the proposals in Ethiopia to build a dam across the Nile, thereby reducing the flow of this vital water supply to Egypt.

A war between Iraq and Syria was narrowly averted in 1975 where Syria had begun to store upstream Euphrates water.

In south-east Turkey, the large Ataturk dam - now nearing completion - and a number of smaller dams could, according to some experts, cut the flow of Euphrates water into Iraq by two thirds. If the Iraquis could be involved in a seven-year war with Iran over *territory* one can readily appreciate the possibility of Iraq being involved in a war over *water*.

In summary, wars for control of water seem a real possibility in the entire area stretching from the origins of the Euphrates in Turkey, of the Nile in Ethiopia and the smaller rivers feeding the "Fertile Crescent". In addition to the *supply* of water, *quality* is often poor so that expensive treatment is necessary and "bottled" drinking water may be two orders of magnitude more expensive than water from a tap.

It is gratifying to note that the pressure for war - for water supplies - has been reduced in some Middle-East countries that have taken desalination seriously, such as Saudi Arabia, Bahrein and Kuwait, where 95% of its water supply is by desalination of sea-water. The desalination plants are, of course, fueled with oil - of which these countries are not in short supply - and they have the necessary financial means. Egypt's efforts in this direction are constrained by lack of capital.

About 4.5×10^9 cu.m/yr of water is currently obtained in the world from fuel-fired desalination plants but it is sad that in purifying the water, we are polluting the atmosphere!

Water supplies also represent increasing problems in other areas: to quote just a few: the Caribbean islands, California and Brazil. Whilst one might not expect to see California involved in a war over water supplies, the possibility in South American and Caribbean countries - where wars erupt for all sorts of reasons - is considerable.

The relevance of all this to the subject of this lecture is that an adequate, renewable - and preferably clean - source of energy can solve the water shortage problem in almost all areas: local unclean water supplies can be purified; sea-water can be desalinated and, where no local water sources exist, it can be shipped in from other areas if one is prepared to pay the cost of transport which is, in the final analysis, an energy cost.

We have seen that wars have been fought in the past - and appear even more likely in the future

- to assure fresh water supplies. And if I concentrated on the subject of fresh-water, I chose this rather than energy, because, as mentioned earlier, we have historical records covering a 4000 year period and because *energy* shortage was not a problem.

Meanwhile, the world has changed - in particular since the industrial revolution - and assured energy sources have become important even in areas where there is no water shortage - and this factor has also been a cause of friction between states.

Only a very naive person could fail to see a connection between energy supplies and the current Gulf crisis (that had not arisen when this paper was written) which crisis is superficially concerned with the question of the acquisition of territory by force - and we are all very conscious of the possibility of forces in gigantic proportions, being used to settle the issue.

So we can couple shortages of energy sources and of fresh water (which latter is essentially also a matter of energy) as causes of wars and it is here where harnessed solar energy can contribute to peace.

For most of the areas of the world to which I have referred, there is no shortage of area available to trap the energy needed

At the local level, small supplies of water can be obtained from wells, using PV cells: many installations exist and though they seem expensive, their viability - even without a fall in prices resulting from increased markets - will improve as the need for potable water grows.

This is not a discourse on solar distillation but I will mention a few approaches to indicate the possibilities

Simple solar stills have been used in the past for purifying small quantities of water but the installations, such as that at Patmos (Dodecanese Island), have gone out of commission as alternative cheaper sources became available. It is quite possible that systems of this type will return for some specific applications.

On the large scale, the last decade has demonstrated methods of harnessing solar energy in MW quantities (thermal or electric) that can be used for large-scale desalination of sea-water, as well as for pumping this water over long distances. Many of the countries needing potable water supplies have good insolation so that only the raw water - not the energy - needs to be imported

As an example of "solar energy for peace", Israel and Jordan, that have common boundaries along the Jordan River and the Dead Sea - and a rather shaky co-operation on the division of water supplies - could co-operate on a solar desalination project: the raw water could come either from the Mediterranean or from the Red Sea: hydro-electric power could be generated en route to the Dead Sea (400 m below sea level), as has been seriously proposed - though the proposals were dropped as being uneconomic when calculated only as hydro-electricity projects. However, the arrival at the Dead Sea of large quantities of sea-water would allow the operation of large desalination plants which, without this raw material, is currently not possible. For example, using solar-pond + multiple effect distillation technology, the expected 30% shortfall in Israel's water needs and the 20% shortfall in Jordan's needs could be provided by less than 200 sq.km. of solar-ponds, using today's technology. Note that the total area of the two states is 116,000 sq.km, of which more than half (for each state) is desert. (Solar-electricity driving a reverse-osmosis desalination plant would take a much smaller area, but a full engineering and economic study is needed to determine if this is a preferable alternative).

It is possible to list many examples of how and where harnessed solar energy could contribute to the water needs of the Middle-East - the area I have chosen for discussion - and to extend the list to many other areas of the world where a shortage of potable water, if not currently a source of international confrontation, can be expected to become so in a few decades, if not earlier. Near-at-hand - in the developed world - is the whole of the Mediterranean basin: southern France, Italy, the Greek islands, where the shortage of clean water is already serious. The problem can be solved if, in addition to the necessary capital investment in desalination and purification plants, an adequate supply of energy is available, e.g., nuclear or fossil, both of which have undesirable environmental impacts, or clean energy from the sun. One consequence is that the cost of potable water will rise. The lowest cost of desalinated water, with present technology when the energy is free, is around $ 0.40/cu.m.: with energy from conventional sources, the cost rises to nearer $ 1 - or even more in some cases. These costs are much higher than water from the usual sources and society will have to become used to these higher costs. Conservation, or saving - in agricultural use arising from the development of crops that are resistant to relatively high salt concentrations and the application of the now-developing science of bio-engineering that promises larger yields per unit of land area and water consumption - is of great importance in the battle against future water-shortages but they only postpone the day when large-scale desalination will become imperative.

In summary, the ever-increasing need for potable water will lead to competition between states - that could, as history shows, lead to war. Large-scale desalination demands large amounts of

energy and society will have to choose between the conventional polluting sources and clean, renewable energy from the sun (which includes wind and hydro-power).

5. Conclusions

Solar energy - and, more generally, renewable energies - have many characteristics that qualify them as peaceful energies. They have no known military application. The technologies on which they are based, even if occasionally quite advanced and sophisticated, have little or nothing in common with any military technology. Solar energy has a positive connotation and image with the general public, and this is rooted in traditions dating back centuries or millennia.

Renewable energies depend on local resources - plus a common, far-away source isolated from human control and intervention, the Sun. With few exceptions (like hydropower deriving from a multi-state basin) they are free from interference among states, and are therefore unlikely to cause international tensions.

Environmental effects of renewable energies are very modest, and practically none of them are global (with the possible exception of a small contribution to global warming deriving from the change in average albedo as a consequence of a large-scale deployment of solar collectors). This is another reason not to expect tensions or conflicts deriving from the exploitation of these energy sources.

Rather than simply not providing causes of international tensions and conflicts, renewable energies may provide a positive contribution to the cause of peace by removing other reasons for confrontation and litigation. In general, renewable energies can improve the standard of life of the most deprived countries and strata of the population. They can contribute in particular, as we have seen, to solving the problem of the scarcity of water in some of the most critical regions of the world, an impending cause of major crises in the future.

However, in order to put renewable energies to work for peace in the best way, a high degree of international collaboration is needed. Technological know-how is very unevenly distributed; much of it is present mostly in the industrialised coutries. However, a simple transfer of technologies will generally not work: the conditions in the receiving countries are often very different from those in the country of origin for climatic, cultural, social reasons, for their organisation and for industrial and other infrastuctures. Technologies must be adapted to the local conditions and this is particularly true for renewable energies, which rely on local sources with their specific characteristics, and which are by their nature deeply embedded in the social and cultural texture. Technology has therefore to be adapted to the particular needs and conditions, and this can effectively be done only with the intervention of the local people. Technological cooperation to carry out this operation as well as capacity building in the less endowed countries are essential pillars of a successful renewable energy programme.

Capital is also a scarce resource, and renewable energies have a relatively high specific intensity of capital (each intervention may be very small, but the amount of investment say per kW installed is generally greater than for fossil fuel plants, a fact that will be repaid by their much lower running costs). International agreements may open the way for fruitful long-term investments in renewable energy installations.

In conclusion, the development and diffusion of renewable energies, in the frame of a broad international cooperation as well as of regional agreements may powerfully contribute to maintaining peace and preserving natural resources and environment for the whole of mankind. In this sense, a covenant among nations for the *proliferation of solar energy*, proposed as one of the recommendations of this conference for the next decade, may be seen as the counterpart of the Nuclear Non-Proliferation Treaty as instruments for preserving world peace.

As we have observed, the diffusion of renewable energies also requires the build-up of indigenous capabilities in science, technology and in other aspects relative to the implementation of a large-scale solar energy programme: and this is another of the long-term recommendations of the present Conference.

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