RENEWABLE ENERGY PARTNERSHIP
EUROPE - MIDDLE EAST - NORTH AFRICA

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ABSTRACT:

Renewable Energy (RE) is the best alternative to cover the world's increasing demand for electricity in view of the increasing fossil fuel prices and expected negative climate impact due to increased burning fossil fuels.
It is more economic to harvest the good resources and convert them to electricity to be transported to the regions where electricity is needed, rather than using poor resources found near the demand.
To achieve that, a renewable energy partnership shall be established between countries having good RE resources and countries with high electric energy consumption. For example Europe and the countries of North Africa and the Middle East, whereas transportation lines with high voltage direct current would enable the transfer at reasonable costs.
Benefits as clean environment, prosperity, employment and availability of desalted water are expected for the participants of the partnership.

1. INTRODUCTION

The highly industrialised continent Europe, consuming about 2450 TWh of electricity per year, possesses limited natural resources of energy compared to the demand [1].
Hydro-power resources are nearly completely used for electricity production.
Large sites with wind energy of high potential (9 to 11 m/s yearly average) are available only in northern Norway, northern Denmark and Scotland [2]. All these sites are affected simultaneously by the northern European weather. In general the wind there is strong in winter and weak in summer. It may even come to wind still as happened in summer 2003 thus negatively influencing the availability of electricity and security of supply.
Connecting the a.m. good wind sites with equally good wind sites having opposite seasonal characteristic, may compensate the uncertainty in electricity supply. Such sites are available in North Africa, on the west side of the Gulf of Suez in Egypt (10 to 11 m/s yearly average [3]) and southern Morocco/northern Mauritania, where the northern trade winds are blasting (9 to 10 m/s yearly average [4]). Both sites have significantly higher wind velocity in summer than in winter [3], [4], [5].
To increase the supply security, Sun-Power from North Africa and Middle East shall support the wind power [6], [7], [8]. In fact wind power alone will not master the job.
Electric energy produced by solar thermal power stations offer - moreover - the option of desalination of seawater from their waste heat at reasonable costs. This would contribute to cover the increasing water demand in North Africa and the Middle East.

High voltage direct current (HVDC) transmission lines, a mature technology today, enable economic and safe transportation of electricity over several thousand kilometres [9], [10]. In this contest the industrialised countries help developing countries to build up a high potential of renewable energy (RE) using their available resources. The surplus energy is bought by the industrialised countries, thus enabling the developing countries to buy more equipment from the industrialised countries to raise their RE production. The industrialised countries will then spend money in production and investment thus creating jobs in their own countries instead of spending it for burning fossil fuels thus spoiling the atmosphere.
One of the initiatives to promote this concept is TREC, Transmediterranean Renewable Energy Co-operation, a network of devoted scientists from Europe and the Middle East. TREC does not only point out problems, it is offering a strategy to solve fossil fuel scarcity and realise prosperity, energy security and safety in an energy and technology exchange pool around the Mediterranean [11].
Two studies - commissioned by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and conducted by the German Aerospace Centre - proved the economic feasibility of producing electricity in Middle East - North Africa and transporting it to Europe presented its results recently [8], [9].

2. STRUCTURE FOR THE PARTNERSHIP:

The back bone structure for the proposed "Partnership" is the Mediterranean Transmission Line Ring.
The idea was born 1987 by former minister of electricity and energy in Egypt, Mr. Maher Abaza, as he suggested the project to Mr. Algot Özal, prime minister of Turkey.
Several meetings and conferences followed resulting in signing the first contract in Rome in October 1998 with participation of most countries around the Mediterranean. This contract envisaged the Mediterranean Ring with 400 kV cables and lines. Three paths for the connections south-north were planned see fig. 1:

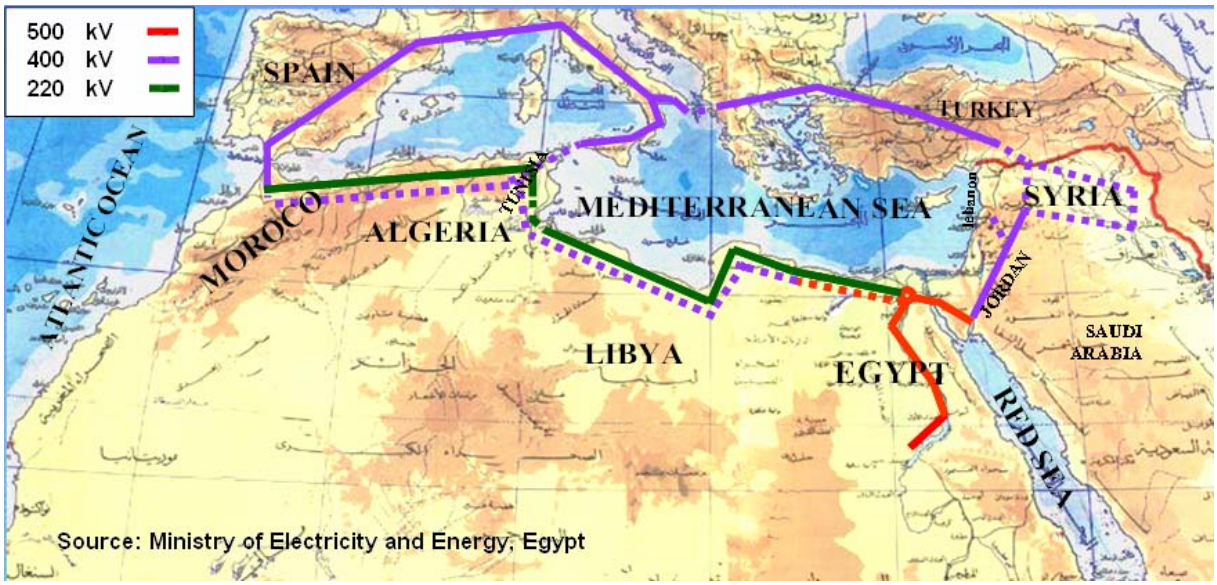

Fig. 1: Mediterranean Ring, electricity connections around the Mediterranean

- On the east side: Egypt, Jordan, Syria, Turkey and through the Bosporus with a marine cable to the European grid in Greece.

- On the west side: Libya, Tunis, Algeria, Morocco and across the strait of Gibraltar with a marine cable to the European grid in Spain.
- From Tunis with a marine cable to the island of Sicily and from there to the southern tip of Italy.

On 1st and 2nd December 2003, again in Rome, the final document was signed by the ministers responsible for electricity and energy of the Mediterranean countries to complete the ring and to add two more marine connections to it, Algeria-Spain and Algeria-Sardinia.
Today the ring around the Mediterranean is nearly completed. The 400/500 kV three phase AC line from Egypt to Jordan is capable of transporting 250 MW. And the 220 kV line between Egypt and Libya is being reinforced by an additional line of 400 kV (dotted line in fig. 1 now on operational trials). The remaining connection between Libya and Tunis is being commissioned now.
Tunis, Algeria and Morocco are already connected to Spain and synchronized with the European grid.
The marine connection from Tunis to Sicily through the Mediterranean has started and is planned to go in operation by end of 2007.

The Mediterranean ring is just the beginning of commercial electricity exchange between the connected countries because it is obvious that its capacity is limited and the losses for long distance transmission are higher than tolerable limits.
For these reasons another transmission technology shall be adopted, namely the High Voltage Direct Current (HVDC) connections. These shall connect with high performance lines, each line capable of transmitting 5 GW, from collection centres of renewable energies in North Africa and Middle East directly to the demand centres in central Europe. Figure 2 shows three examples of such connections.

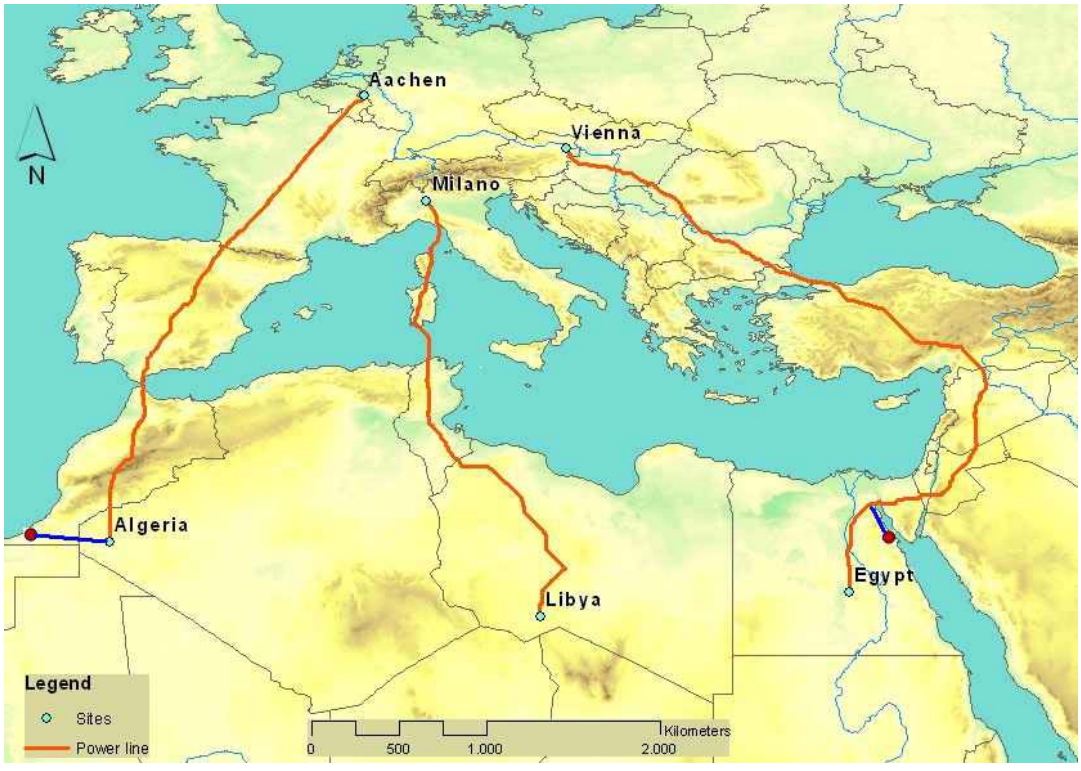

Fig. 2: Three examples of HVDC lines connecting Europe with MENA, Source [9]

3. TARGETS FOR THE PLANNED PARTNERSHIP:

The "Partnership" proposed in this paper aims to:

- Harvest wind power of high potential (10 m/s) from the Gulf of Suez and the Moroccan Atlantic coast.
- Harvest Solar Power of high potential (up to 3000 kWh/m²/y) from nearly every where in the North African Sahara.
- Transmit the harvested clean electricity to Europe via HVDC lines at reasonable costs of about 0.01 €/kWh [9]
- Mutual benefit for all partners in this co-operation.

A political and financial framework is essential to govern actions and activities of such a huge project, whereas it shall be considered:

- At the start phase strong support from the European countries to the MENA-countries will accelerate the development.
- Clean electricity from MENA shall cover - in the first stage - only about 10% of Europe's total consumption.

4. PRACTICAL EXAMPLE:

The framework suggested here will be explained using an example for better comprehension.

Considering a Practical case:

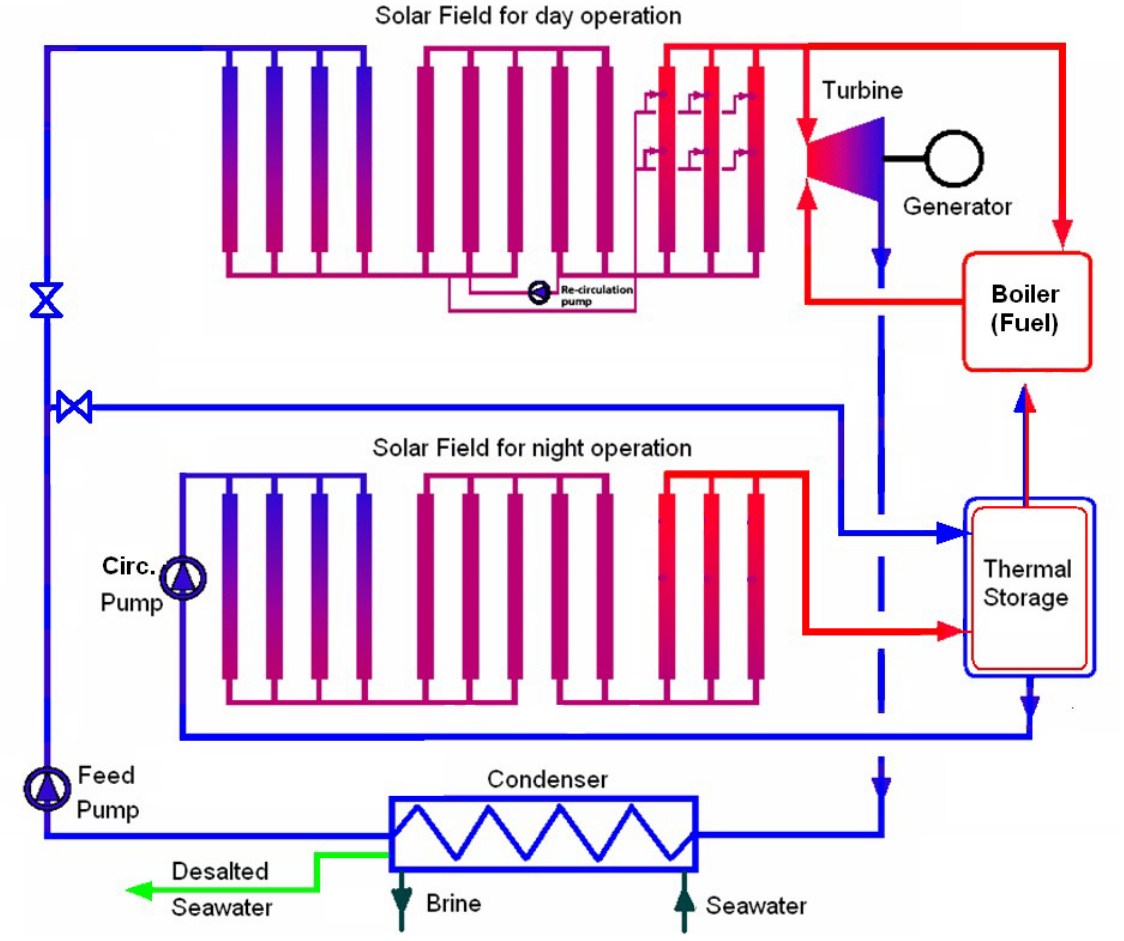

Fig. 3: Solar hybrid Power Station with storage and seawater desalination

- A European company establishes together with a company from Middle East-North Africa (MENA) a wind field or a solar power station* in a MENA country.
- Solar-Hybrid concept (using fossil fuel in the night) is preferred to ensure supply on demand, till the technology of heat storage is commercially available, see fig. 3.
- The solar electricity share of at least 20% will be transmitted to Europe while the conventional share will be consumed in the MENA country.
- Beside electricity, desalted water will be produced from the waste heat of the power station, thus boosting the economies.

What can the MENA-country do?

- Offer free land and infrastructure.
- Buy the conventional electricity share
  (for example at 0.025 €/kWh depending on fuel price)
- Buy the desalted water produced from waste heat
  (for example at 0.50 €/m³)
- Guarantee by law capital security.
- Free from taxes for the first 10 years

What can the European country do?

- Set a quota for clean electricity, which is increased each year by 1% points over the actual value for each electricity producer. This is compatible with the target of 20% RE share in 2020 set by the European Commission.
- Extend support to clean electricity for supplies from outside the country.
- Set incentive prices for clean electricity import
  - for example 0.12 €/kWh for solar electricity
  - for example 0.08 €/kWh for wind electricity
    to cover the costs of production and transmission.
- The incentive price is valid only for the clean share of a hybrid system.
- The incentive price is guaranteed for 10 years.
- After 10 years it is reduced by 10% points each year.

5. WHAT ARE THE „WIN OBJECTIVES“?

- Europe wins:
  - Clean and cheaper electricity
    (price goes down instead of climbing fossil fuel prices).
  - Employment due to machinery exportation.
  - Investing capital instead of burning fossil fuel.
  - Diversification of energy supplies.

- MENA wins:
  - Water in considerable amount.
  - Sells electricity for a reasonable price.
  - Social and economic development.
  - Employment and winning technology knowledge.

* We will continue our example with the solar power station because it needs more details than wind fields.

- Environment wins:
  - Less CO_2 emission.
  - This system encourages developing of low cost equipment and extending the solar share to 100% using heat storage, a technology that is not yet commercially available for large scale.

Example for a low cost solar thermal power station using flat mirrors and providing shadow under the mirrors for planting vegetables or any other domestic usage taking advantage of protection against the direct sunrays.

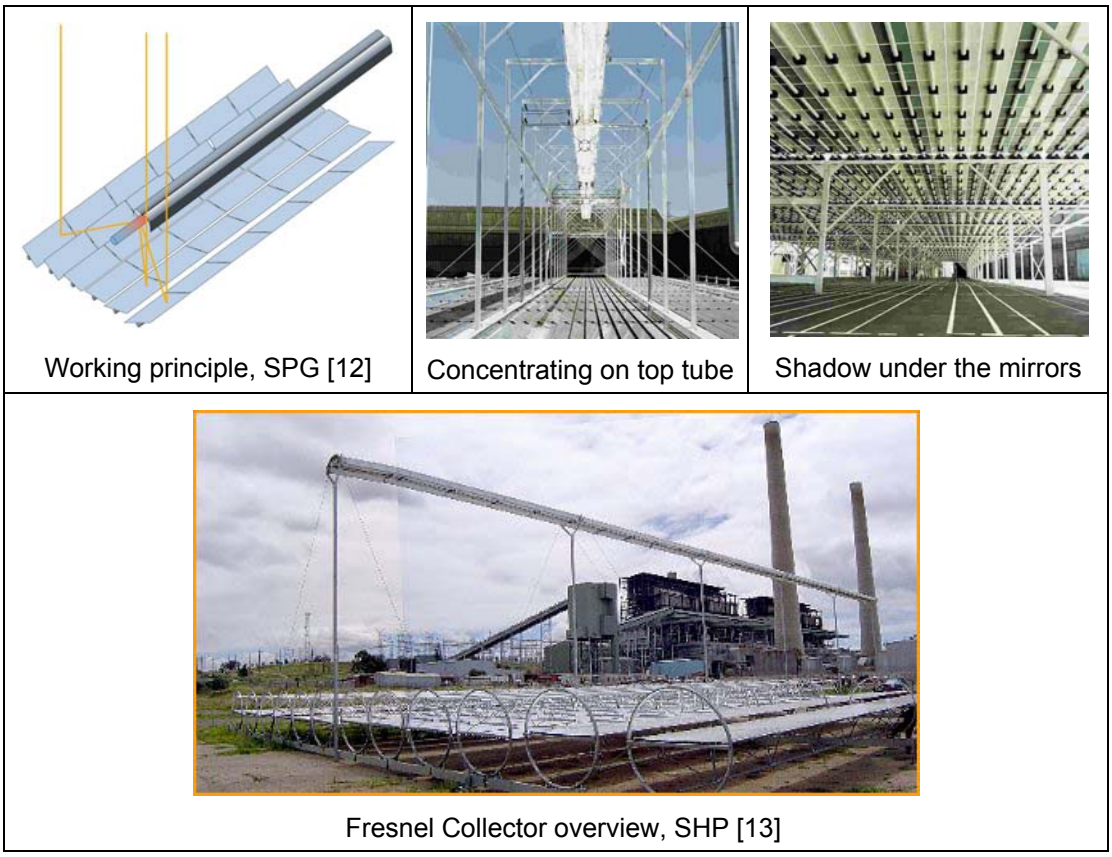

Fig. 4. Fresnel flat mirror technology for concentrating solar power

ACKNOWLEDGMENTS

The author thanks former minister of electricity and energy of Egypt Eng. Maher Abaza for his contribution to the details of the Mediterranean ring, his encouragement to publish this paper and his allowance to publish his key note speech at CIGRÉ, Paris 1994.

The author thanks Dr. Hassan Younes minister of electricity and energy of Egypt for supporting this study with the map of the Mediterranean ring (fig. 1).

The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety promoted the studies of MED-CSP and TRANS-CSP and is now promoting AQUA-CSP.

The author thanks Dr. Franz Trieb for his contribution to the a.m. studies.

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