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THE FIRST INTEGRATED SOLAR/COMBINED CYCLE ELECTRIC GENERATION PROJECT IN EGYPT

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Arab Republic of Egypt
Ministry of Electricity & Energy
New & Renewable Energy Authority "NREA"

THE FIRST INTEGRATED SOLAR/COMBINED CYCLE ELECTRIC GENERATION PROJECT IN EGYPT

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1. INTRODUCTION

Egypt has been always concerned by securing energy supply on continuous bases, which considered of prime importance for sustainable development. Of equal importance, Egypt has been also keen in diversifying its energy resources and achieving an optimum mix.

Since Mid Seventies, Egypt has given due consideration to developing and utilizing indigenous renewable energy resources where the country has an excellent potential for three of them; Solar, Wind and Biomass. This trend has been promoted by two major factors; firstly the depletable nature of fossil fuels, of which Egypt has limited proven reserves, secondly the world wide concerns of pollution and negative impact on the environment due to burning fossil fuels.

Early eighties of the 20th century, Egypt has formulated a National Strategy for the promotion and development of renewable energy utilization, as an integral part of the long term national energy planning.

In 1986, the New and Renewable Energy Authority, NREA, was established under the Egyptian Ministry of Electricity and Energy to provide the institutional framework of implementing the renewable energy strategy and act as a focal point for expanding efforts to introduce renewable energy technologies to the Egyptian context, starting by limited scale experimental phase followed by medium scale demonstration phase – up to large scale commercial one.

In the course of implementing the said renewable energy strategy, NREA has been periodically reviewing and updating it to reflect projections for possible contribution of renewable energy technology / application options, to the strategic goals.

The present target is to cover 3 % of Egypt's electric demand through renewable energy resources by the year 2010, with additional contributions of other renewable energy applications such as solar heating for both domestic and industrial processes heat purposes, wind and photovoltaic water pumping and village electrification, rural and urban wastes biomass treatment for energy production, including biogas applications.

2. EGYPT'S BREEPP PROGRAM

The electricity demand in Egypt is expected to grow at a rate of about 6% annually for the next decade, requiring additional 9000Mw of new generating plants to be commissioned through the period 2000-2010.

It is due to this and the current tremendous development in renewable energy electricity generation technologies that NREA has initiated the Bulk Renewable Energy Electricity Production Program (BREEPP) for large-scale power generation.

The BREEPP concept is based on that the excellent available solar and wind energy resources can be utilized on large scale using advanced technologies, meanwhile the renewable energy generated electricity - in addition to the effective contribution in meeting the said national demand - can also be expanded by Independent Power Producers (IPPs) to allow export clean energy to other countries through the electric grid interconnections currently in progress in the region targeting eventually to form a strong integrated Mediterranean Electric Power Pool (MEPP) . The BREEPP has two main components for both grid-connected large-scale wind and solar thermal electricity generation plants and forecasted to push ahead both technologies to the market place.

In the frame of the above mentioned program and encouraged by the Egyptian favorable solar potential, ranging from 2000-2800 Kwh/m2 annual direct normal irradiance with relatively low variations between different seasons, NREA has formulated in 1994 a long term plan for large scale solar thermal electricity generation systems (STEGS) in three stages:-

Stage1 : Potential assessment & techno-economic studies for large scale plants, based on the Integrated Solar Thermal / Combined Cycle System (ISCCS)

Stage 2: Implementation of the first large scale ISCCS of about 10-15 % solar energy contribution.

Stage 3: Dissemination program.

In the course of achieving stage 1 objectives, studies were conducted to assess the Solar Thermal Electricity Generation (STEG) potential in Egypt until 2020 which has indicated the existing potential reaching a considerable ratio of the available potential in the southern Mediterranean region. As far as large-scale applications are concerned, techno-economic studies were performed concluded with giving the priority to the use of Parabolic Trough Technology (Fig. "1") and the Central Tower Receiver one (Fig. "2").

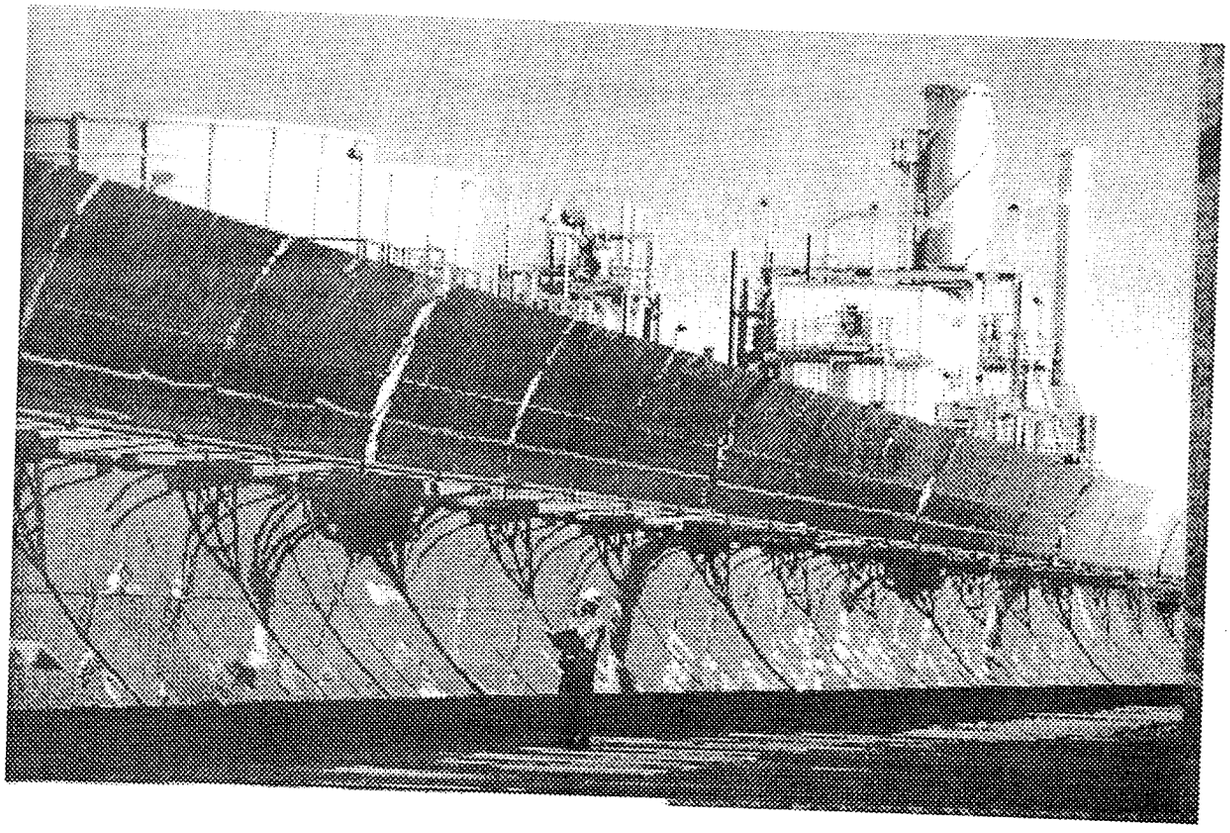


Fig. "1" Parabolic Trough Technology

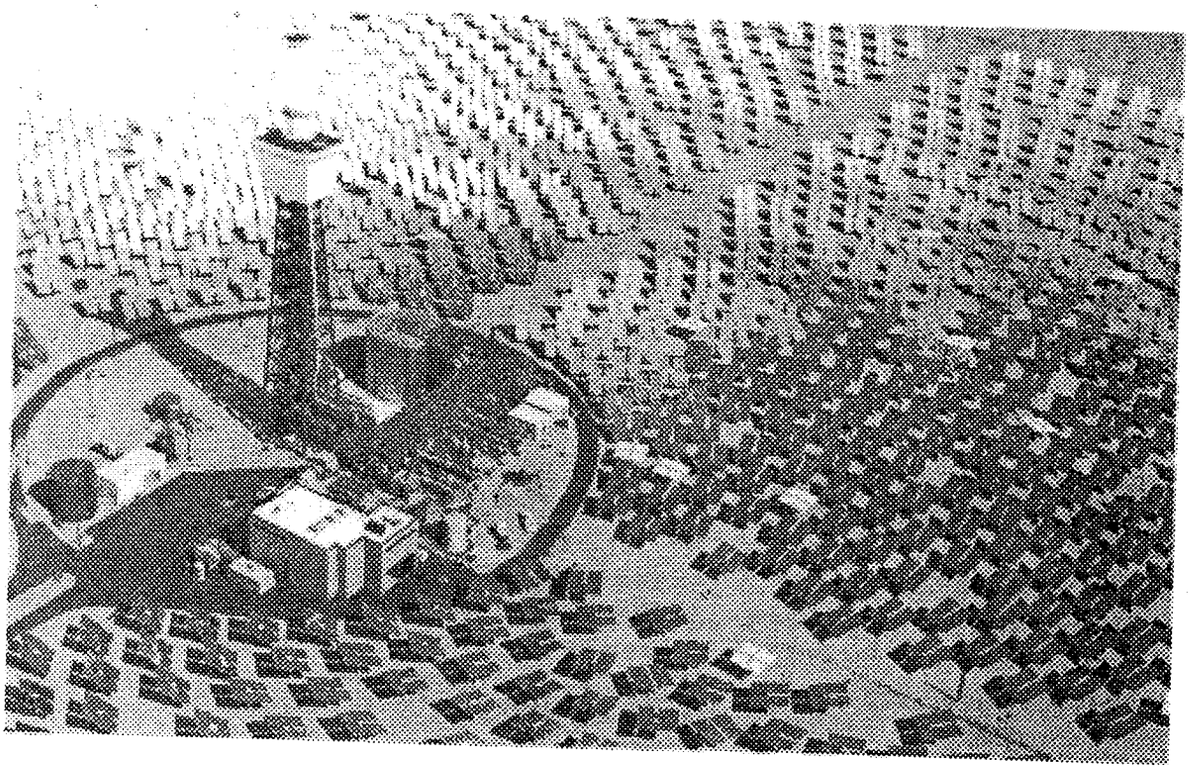


Fig. "2" Central Tower Receiver Technology

This stage necessitated a thorough survey of the internationally available solar thermal technologies as well as a comparative assessment of the level of maturity of each technology for various applications (small / medium / large scale / stand alone/ grid connected . . . . . etc).

The long in-depth studies have concluded the following:

a) Egypt has a large potential for application of the various available matured solar technologies for different purposes on different scales.
b) A plan was formulated to implement a series of large-scale grid connected plants in an overlapped time frame based on ISCCS, starting with a pilot project of about 150 Mwe to be operative by 2003 followed by 300 MWe plants targeting to accumulate 750 MW capacity by year 2010, and hopefully Multi Gws by 2020. This plan was based on the following considerations: -
   1. The Egyptian favoring factors include abundant solar resource, flat desert areas, extended unified electric grid, natural gas pipe line networks, availability of the expertise and local manufacturing capabilities, all coupled with the governmental supportive policies to the development of clean energy.
   2. Plans-under implementation- to interconnect the national power grid to the Mediterranean basin networks, and hence to the European grid in general.
   3. The State Policy encouraging the private developers to establish privately financed and owned power plants as Independent Power Producers (IPPs) based on concession agreements and according to BOOT system.
   4. The growing interest and support given by the various international financing institutions to the clean energy development, within the framework targeting to reinforce the international cooperation for sustainable development and protecting the global environment.

Accordingly, on October. 9, 1996 the Egyptian Cabinet of Ministers has agreed on the establishment of the first "ISCCS" pilot power plant of about 100-150 MW capacity. The fossil fuel used in the system is natural gas.
The first plant is anticipated to be implemented through Build-Own-Operate-Transfer (BOOT) Or Build-Own-Operate (BOO) contract.

3. IMPLEMENTATION STEPS

In the course of achieving stage 2 objective, many implementation steps have been taken in developing the first plant, while others are underway.

NREA hosted the Solar Thermal Analysis Review and Training (START) mission within the scope of technical assistance offered by IEA/ Solar Power And Chemical Energy Systems Executive Committee (SolarPACES EX. CO.) for the analysis of the appropriate solar thermal power technologies for Egypt and review of candidate sites for the first solar thermal project.

NREA in coordination with the Egyptian Electricity Authority (The National Utility EEA) has specified the main requirements of the plants as follow:-

One. Proven Technologies.
Two. Reliable plant configuration.
Three. Contribution in satisfying the evening peak demand.
Four. Financial support covering the incremental cost.

The conceptual configuration shown in (Fig. "3") was selected to satisfy the 1st three requirements, while the 4th requirement initiated the idea of referring to the Global Environment Facility (GEF) operational programs which provide appropriate solution for the problem of the incremental cost.

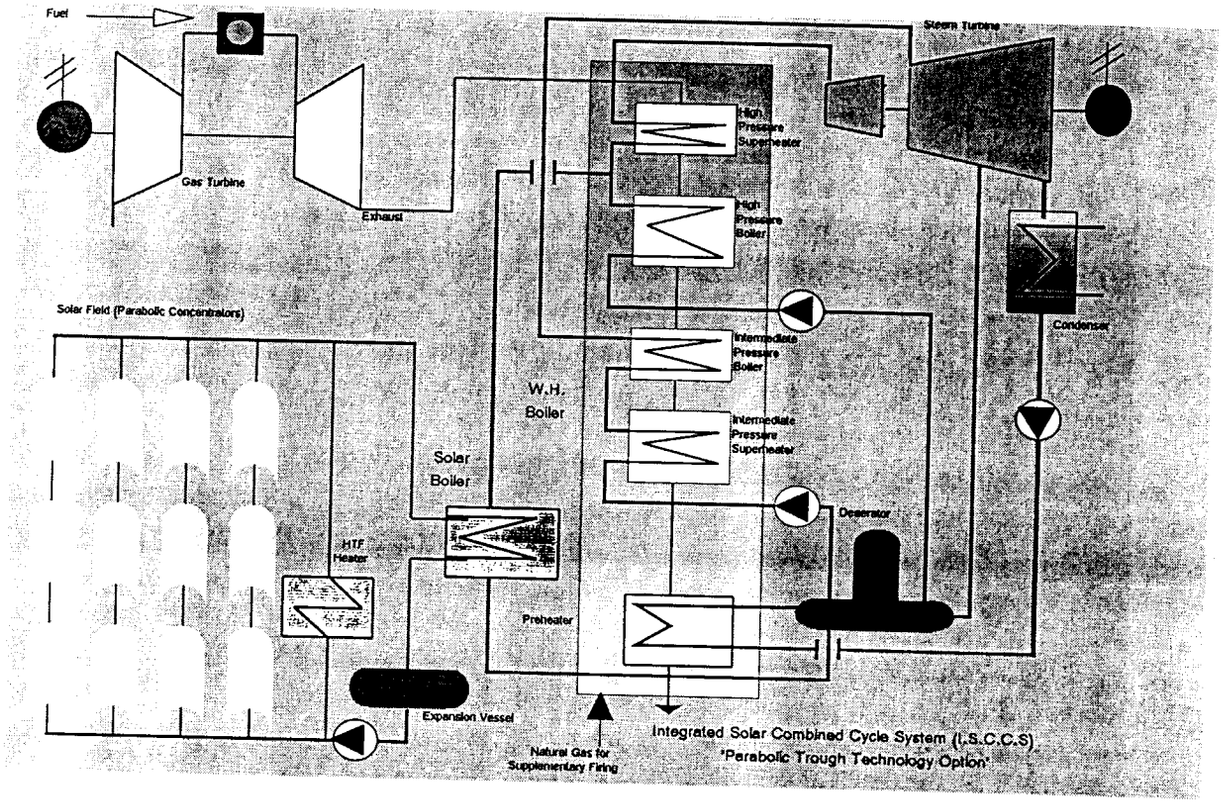


Fig. "3" Integration Solar Combined Cycle System

Two pre-feasibility techno/economic studies were performed addressing the use of the central tower receiver and the parabolic trough technologies through the EC funded "INTERSUDMED" project.

Egypt submitted an official request to the Global Environment Facility through the national focal point, the Egyptian Environmental Affairs Agency (EEAA) to support financing the project which has received positive response stating that GEF is available to finance - through a grant - the incremental cost in comparison to the least cost conventional alternative producing the same annual amount of the electric energy, to be implemented with private sector participation.

GEF has selected the World Bank (WB) as an international implementing agency of the project.

In cooperation with WB, the project documents including the Project Concept Paper (PCP) and Terms Of Reference (TOR) for the consulting services were jointly prepared.

In that time, NREA was not quite confident about the level of interest of private developers to undertake the implementation of such a project as a first of a kind with its innovative concept and configuration, as privately financed and owned one.

The consulting services were subdivided into phases as fallow:

Phase I:

To conduct a feasibility study covering the technical, economic, financial, aspects including identifying the appropriate configuration, plant size, solar fraction, suitable solar technology and conceptual design of the plant, with estimation of the incremental cost in comparison with a reference conventional (C.C) plant producing the same annual energy.

This phase has additionally including:

- The assessment of private developers level of interest in the project
- Short listing of qualified interested developers

Phase II:

- Preparation of the Request for Proposals (RFP) for private developers or any other documents as required.
- Assisting EEA/NREA in the evaluation of the offers, including support in negotiations with the successful bidder.

The Philosophy beyond this sub-division to two phases was to get sure of the adequate interest of private developers to undertake the project implementation as privately financed according to BOT/BOOT system (based on a concession agreement) before identifying the documents to be prepared by the 2nd phase.

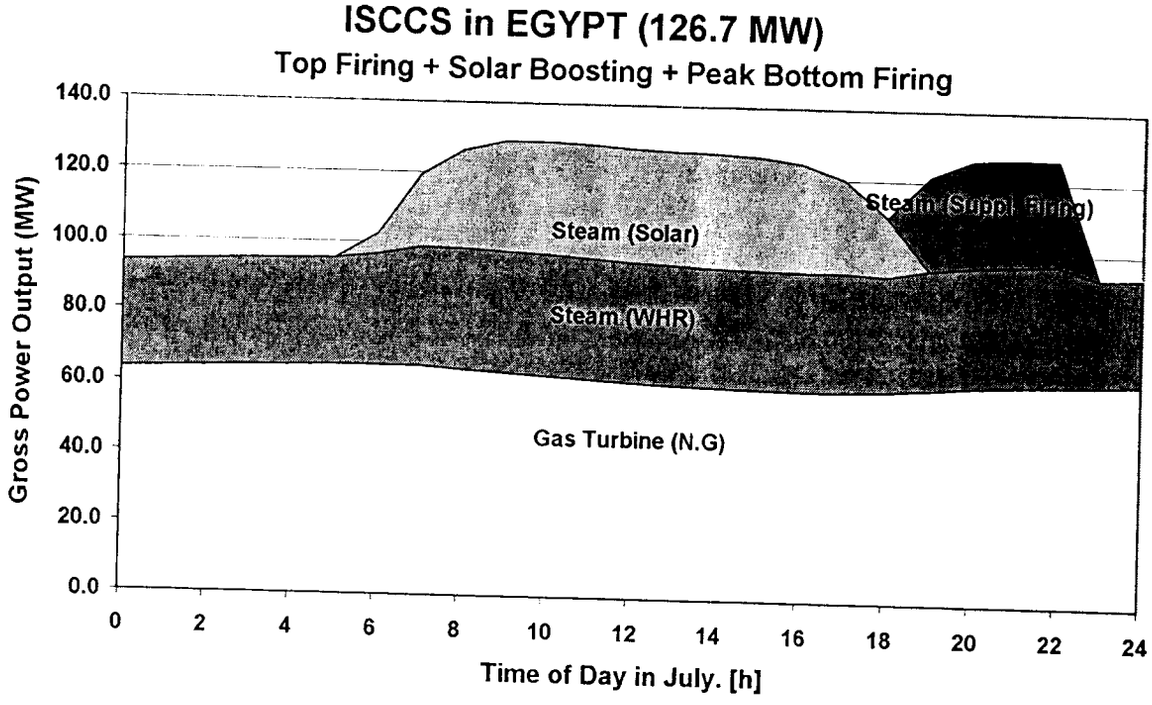
A pre-qualification request was issued soliciting consultation services, where 28 consulting firms applied, proposals were evaluated and a short list of 5 firms was set, and finally the winner consultant was selected for the 1st phase of the consulting services, financed by a GEF Grant from Block "B" Fund.

Meanwhile, the World Bank financed a quick introductory study assessing the level of interest of the private developers to carry out the project. The conclusion of this study showed generally the interest is there. Further, just the consultant completed his tasks in January 2000, an international workshop was held in Cairo to present the project in details and assess the private developer interest in the results of phase I studies. This workshop has formed again a good chance during which the private developers have expressed great interest.

Main technical data of the project can be outlined as follow:

		P.T.*	C.T.**
- Total capacity is around	Mw_e	126.7	126.7
• C.C capacity	Mw_e	95.5	99.0
• Solar field capacity	Mw_e	31.2	27.7
- Total annual electric energy produced	Gwh/Year.	886	888
- Solar energy contribution	%.	9.2	8.3
- Fuel saving / Avoided emission	%.	7.0	6.8

The mode of operation of the plant based on PT is shown in (Fig. "4")



Fin "4" ***Mode of Operation of the ISCCS in Egypt (PT Technology)***

Main economic data of the project can be outlined as follow:

		P.T.	C.T.
- Total investment cost	US$ Mio.	118.5	119.6
• Power block	US$ Mio.	59.3	60.4
• Solar field	US$ Mio.	59.2	59.2
- Levelised Electricity cost			
• ISCCS	US¢/Kwh	3.08	3.07
• Reference power plant	US¢/Kwh	2.44	2.43
• Solar component	US¢/Kwh	9.50	10.19
- Capitalized incremental cost	US$ Mio.	49.9	49.8

*P.T: Case of (Parabolic Trough)

**C.T: Case of (Central Tower)

The TOR of the second phase of the consulting services has been already formulated, standard documents have been prepared to be revised and adapted by the consultant for the RFP, main agreement between the utility and developer, Power Purchase Agreement "PPA",.....etc. The procedure of contracting the ph. II consultant is ongoing targeting to issue the RFP to the developers by beginning of 2001 and aiming to putting the project in the implementation phase by the year 2002, hopefully to have it operative on the National power grid by the end of 2003 or beginning of 2004. (more than 18 months delay in reference to the original schedule).

Official requests have been already submitted to the GEF to allocate the required grant to finance ph. II consulting services (from Block C Fund) and the main grant to cover the incremental cost.

The final decision of the GEF is expected to be taken in the council meeting scheduled to be held in Nov. 2000.

4. CONCLUSION

Egypt has a strong commitment for the development of solar power plants using its rich solar resource to both meet increasing electric demand posed by the fast development and to mitigate pollution problems.

The first ISCCS plant will offer the opportunity to test and evaluate such concept under the Egyptian conditions while allowing the Egyptian staff acquire necessary hands on expertise required to carry on the long term ambitious plan along with possible modifications looking for achieving, hopefully, most successful results that will indeed benefit those who are looking for similar projects worldwide.

It is worth mentioning that the ambitious BREEP program has a plenty of room for innovative technologies approaching maturity such as Beam Down Solar Concentrated Off-Tower (SCOT) central receiver technology that can be used whether as grid connected or as stand alone system in remote desert areas far from the electric grid.

In this regard, 10 Mw_e joint demonstration project is planned to be implemented in Egypt, within Egypt / US "Implementing Arrangement for Cooperation in the Field of Energy" signed on July 1st, 1999.

The techno-economic study phase is currently being prepared including the conceptual design/configuration, cost elements and means of economic improvements such as local manufacture of all possible components by the Egyptian industry through Technology Transfer arrangements. (Fig. "5&6")

The STEG long term plan as a part of the BREEPP targets to implement a chain of plants in an overlapped time frame to accumulate Multi GWs by the year 2020 (750 Mw out of which by the year 2010).

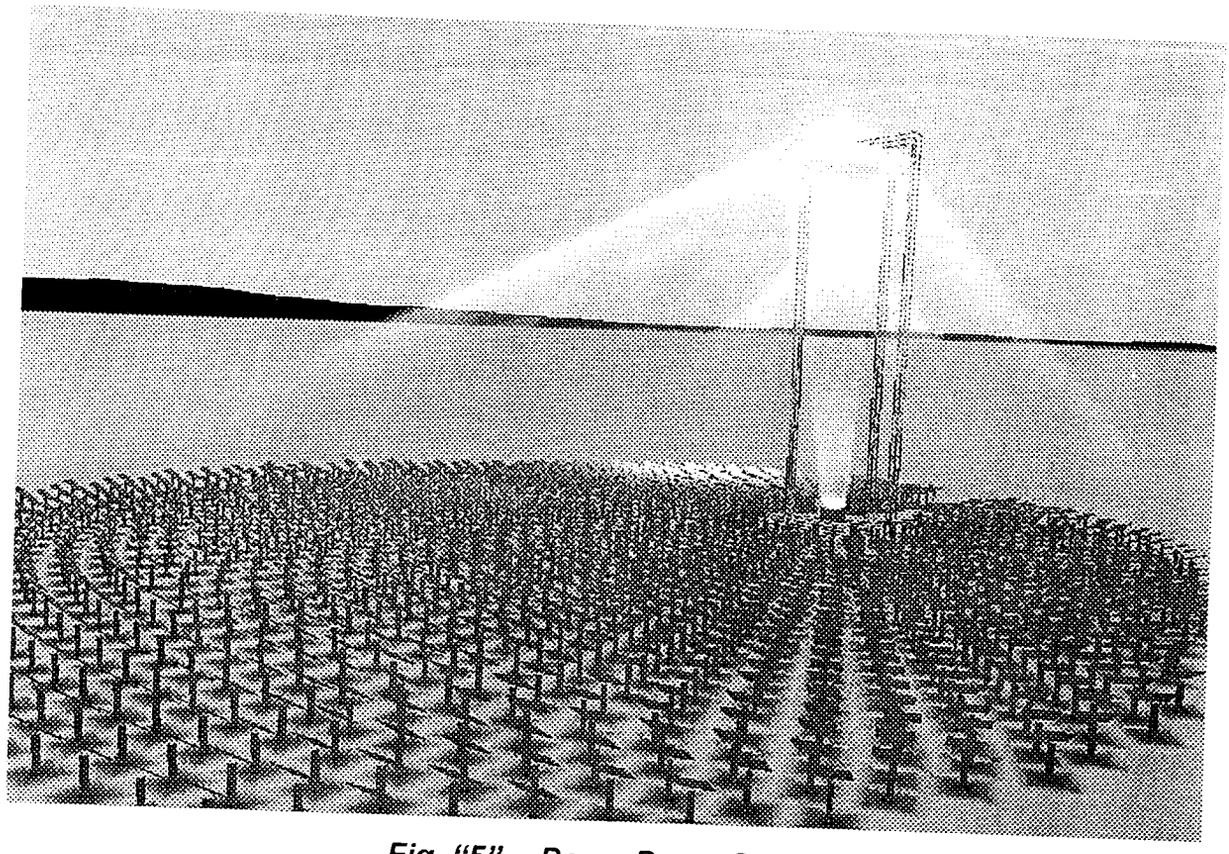


Fig. "5" Beam Down System
Solar Concentration Off-Tower Technology (SCOTT)

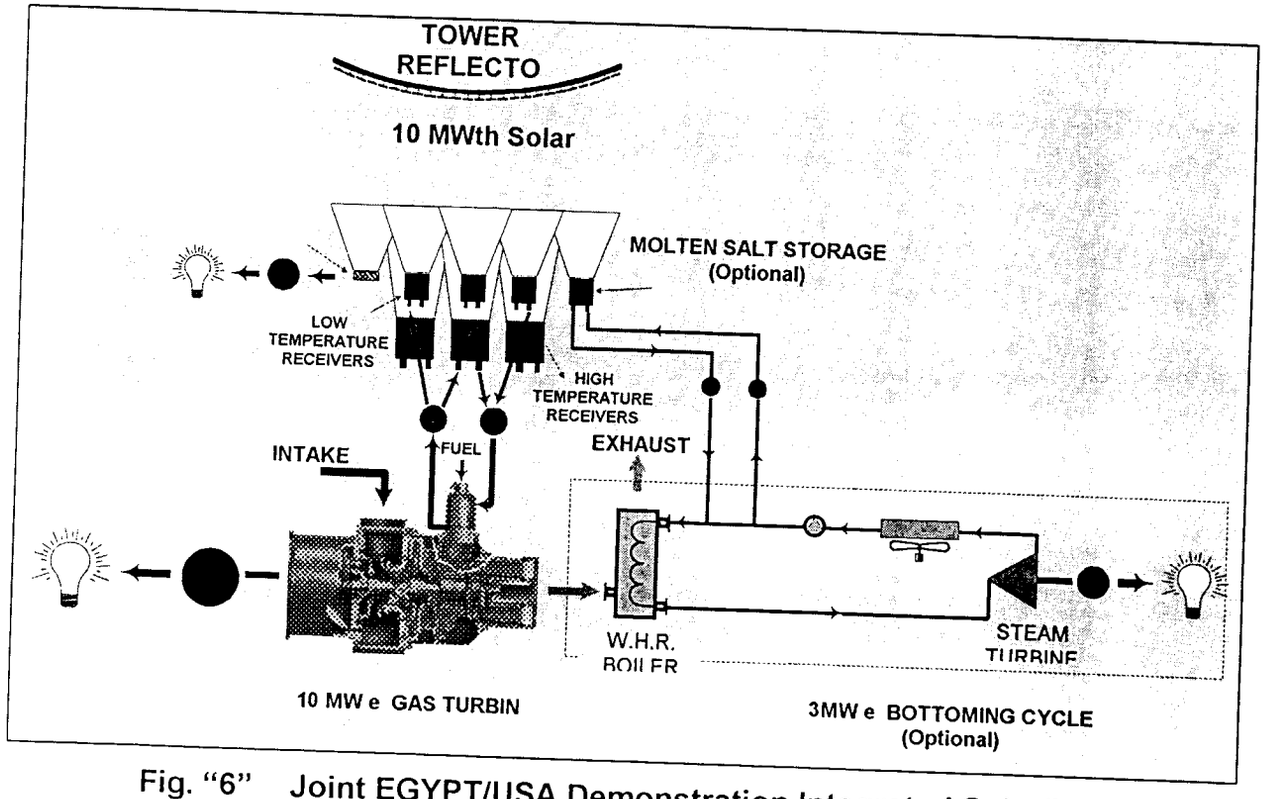


Fig. "6" Joint EGYPT/USA Demonstration Integrated Solar/Fossil Combined Cycle Power Plant – 15 Mwe (in phases 10+5)

References:

- "Strategy of Electricity Power Sector", **Ministry of Electricity & Energy**, 1980.
- "Strategy of Renewable Energy in Egypt", **NREA**,1981.
- "Solar Atlas of Egypt", **NREA / USAID**, .
- "Bulk Renewable Energy Electricity Production Program (BREEPP) ",**NREA**, 1994.
- "IEA/SolarPACES, START Mission Report",1996.
- "Pre-feasibility Study of Solar Thermal Power Plant With Central Receiver Technology for Egypt", **Sevillana De Electricided, Spain / NREA**, 1997.
- "Conceptual Design foe a Parabolic Trough Solar Field for Electricity Production in Egypt", **ENDESA, Spain / NREA**
- "Egypt's Renewable Energy Strategy & Programs", **M. S. Zannoun**, 1997.
- "Egypt's Solar Thermal Power Generation Program, Prospects and Current Status", **M. S. Zannoun & A. I. Hegazi**, 1998.
- "Annual Report of EEA", **Egyptian Electricity Authority**, 1999
- "Pre-feasibility Study Reports on the 1st ISCCS in Egypt", **LAHMEYER International / NREA**, Jan 2000.
- "Feasibility Report of the Project", **LAHMEYER International / NREA,** Jun 2000.