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Special Session 3

Renewable Energy Structures

Constructions en vue de l'utilisation des énergies renouvelables

Konstruktionen zur Nutzung der wiederverwendbaren Energien

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Large Scale Solar Power Stations in India

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SUMMARY

Need for immediate action for the setting up of large scale solar power stations in tropical countries such as India is highlighted. Characteristics of three different systems, already used elsewhere, have been compared with the possibilities existing for utilisation in developing countries. The Solar Chimney (atmospheric power tower) has been identified as a good choice for the given conditions. A proposal is suggested for working out detailed designs for a 30 MW Power Station in India.

1. INTRODUCTION

Out of the different options we have as Renewable Energy Sources, Solar Power is the most abundantly and most widely available Renewable Source of Energy. During the last 2 or 3 decades when extensive work has been going on for tapping the Renewable Sources of Energy it has been realised quite early that such attempts can be broadly classified into two categories namely:

(i) Schemes for SMALL SCALE decentralised power generation

(ii) Schemes for LARGE SCALE centralised power generation

Because of the generally low efficiency of the systems making use of renewable sources of energy initial work in the area has been mainly on small scale systems. Only recently efforts are being directed more and more towards setting up of large scale plants, for example, as in the case of wind mill forms for Wind Energy; Distributed Collector Systems, Centralised Receiver Systems and Solar Chimneys for harnessing solár power.

2. LARGE SCALE SOLAR POWER GENERATION

The three currently available large scale power generation systems using solar energy are:

(i) Distributed Collector Systems (DCS) using parabolic trough collector systems

(ii) Centralised Receiver Systems (CRS) using large number of heliostats with a large scale solar tower at the middle

(iii) The Solar Chimney (Atmospheric Power Tower),using large area at the base of chimneys for collection of heat from solar radiation

When options available are more than one there is a natural tendency amongst the scientists and technologists to start discussing which of the alternatives is the best one. It is no doubt a healthy form which leads to rational decisions leading to most economical solutions. We the inhabitants of this world are, however,today unfortunately not in a position to allow ourselves enough time for such an extended discussion. As per reasonably accurate forecasts made by experts in the field the conventional energy sources available on our planet - Fossil Resources except coal which is a highly pollutant fuel - are to get completely exhausted within the next to 30 to 40 years (Table 1). Hence the urgency of the situation demands that we make use of all methods of generation rather than losing time on discussing which system is to be used. A parallel for such a situation exists already in

India where the quality of coal available everywhere is so poor that while operating the thermal power stations in India it is no longer discussed for about which coal is to be used. Coal from all sources is used as per the availability. Thus there is a strong case for trying out all available methods for centralised solar power generation in developing countries like India which happen to be in the tropical zones and are thus endowed with large amounts of solar radiation.

3. CASE FOR SOLAR CHIMNEY (ATMOSPHERIC POWER TOWER)

While there is a strong case for introducing all available proven systems in India, even a cursory evaluation of the available systems seems to indicate that the system based on the Solar Chimney has got certain advantages for a country like India. The Distributed Collector System using Parabolic Trough Collectors heating up a suitable fluid carried through pipes along the axes of the collectors makes use of a very sophisticated technology (because the troughs have to track the sun) and is heavily dependent on foreign exchange requirements. Also the maintenance of such a system seems to require very sophisticated establishments. The technology used in Solar Tower (Centralised Receiver System) is even more delicate and sophisticated because it requires very accurate controls which keep moving the heliostats around two axes to track the sun's movement for most efficient energy conversion. On the other hand the principle used in Solar Chimney is very simple and construction is so robust that the plant can be set up very easily with technical knowhow and facilities already available in developing countries.

Yet another, very important point in favour of the Solar Chimney is that unlike the other systems which depend only on direct radiation, the Solar Chimney can operate even under diffused radiation. The natural storage medium - the ground - ensures that the plant can operate at a constant rate until well into the hours of darkness. The main advantages of a Solar Chimney can be summarised as given below [1] :

- It makes use of global solar radiation, including diffuse radiation when the sky is overcast
- The natural storage medium - the ground - a 24 hour operation possible with large-scale installation
- Aside from the turbine and generator there are no moving parts or parts that require intensive maintenance
- No water is required to cool mechanical parts
- It features a simple, low-cost design utilizing know-how and materials that are also available in Third World countries (glass, concrete, steel)

A high proportion of the costs is accounted for by work that is simple and can therefore also be done by local labour in developing countries. This would benefit the local labour market while at the same time helping to keep the overall costs down.

4. THE INDIAN SCENARIO

The total installed power generation capacity in the country as on date amounts to about 65,000 MW in which as much as about 70% comes from Thermal Power Stations. In the next five year plan (1992 - 97) this power generation is to be augmented by another 35,000 MW out of which again as much as about 32,000 MW is to come from thermal power stations. Unfortunately the coal quality available in India is so poor that the ash content is sometimes as high as about 40 %. This has resulted in a severe environmental problem. The fly ash production from thermal power plants as on date in India is estimated to be about 40 million tonnes per year and is expected to reach a staggering figure of about 80 Million tonnes by the end of the century. Disposal of this industrial waste is going to be a serious problem.

Furthermore, as coal is available only in Central India region, it has to be transported over large distances to places where thermal power plants are located. The already meagre transport facilities available in India - particularly by rail - are heavily strained with this additional task of movement of coal. In fact the country has embarked upon development of suitable port facilities at a number of locations along its long coast line around Southern India to serve predominantly, if not exclusively, the purpose of feeding the thermal power stations at different locations with coal supplies.

Large scale solar power generation will contribute to mitigate the problems discussed above. For Solar Power generation using the concept of Solar Chimney (Atmospheric Power) the Rayalaseema region in Andhra Pradesh or the Rajasthan Area (Thar Desert) seem to be two of the suitable sites (Fig.1). Out of the two, Rayalaseema seems to be better because most of the region is rocky and barren and thus ideally suited for the Solar Chimney System of operation. For making use of the economies that accrue depending on the size of the plant, a plant with a minimum capacity of 30 MW seems to be desirable. Such a plant is estimated to require

(i) a chimney of a height of about 650 m and diameter of about 45 m and

(ii) a collector area of about 4 square kilometers at the base of the chimney

In India we are already building T.V towers and chimneys upto heights of about 350 m. So building a tower of a height upto 650m should not present insurmountable problems in India. In fact this can be carried out without any great difficulty with the expertise already available with a number of Indian Construction Companies.

To be able to find 4 to 5 square kilometers of area for the collector area in the regions mentioned should also not be a problem because large tracts in this region are

(i) mostly barren with very little habitation and

(ii) subjected to intensive solar radiation through all seasons of the year.

5. SUGGESTED PLAN OF ACTION

Well established and well documented information is already available about the working of a pilot plant established at Manzanares in Spain [2], [3]. Using these already established design criteria, a site specific design should be worked out IN FULL for one of the selected locations in India. The design has to be in great detail taking into account actual realistic data about

(i) metrological and geotechnical parameters of the site chosen

(ii) Material and construction practices and technologies suitable for Indian conditions

The designs should be so detailed in nature that they permit an immediate cost evaluation of the project. Then these costs could be compared with costs of conventional thermal plants but giving proper Weightage also to such additional factors like Costs of environmental protection, waste disposal, transport bottlenecks etc associated with conventional thermal plants. If necessary organisation like United Nation and World Bank could be approached not for financing the initial design costs but also for assistance for the erection of the plant itself according to the finalised design.

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TABLE 1 : AVAILABILITY OF FUELS

FUEL TYPE	MAY LAST FOR A FURTHER PERIOD OF (YEARS)
1. OIL RESERVES	45
2. GAS RESERVES	55
3. URANIUM	80
4. COAL *	250

* (Mostly of very poor quality; particularly pollution intensive)

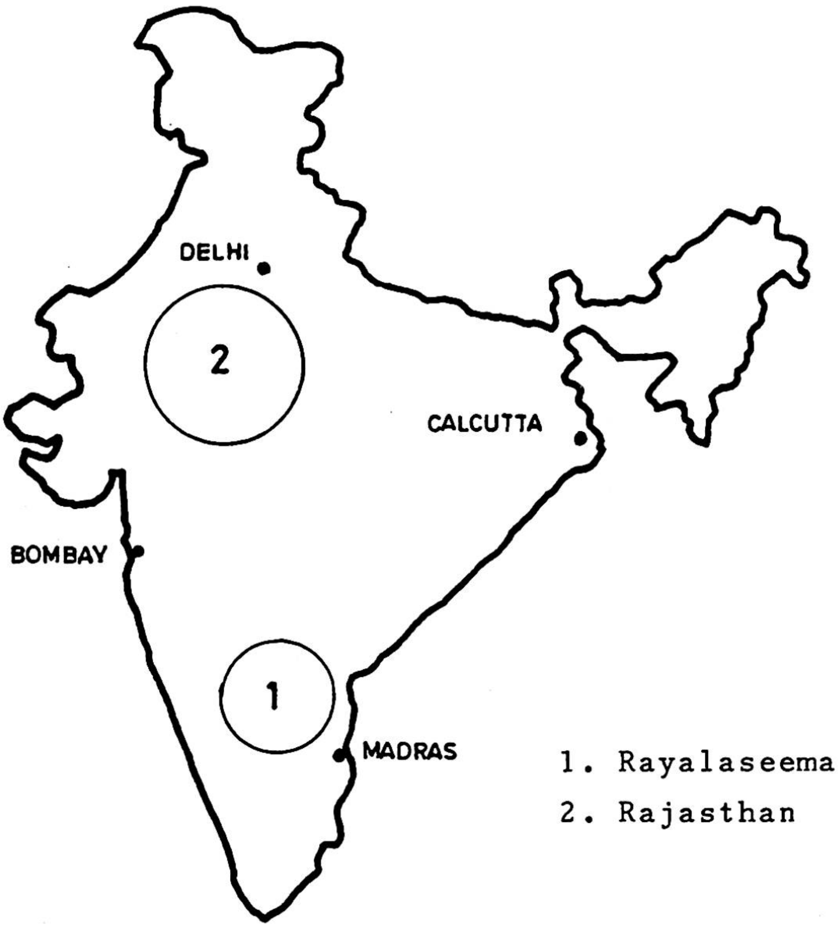

Fig.1 : Large Scale Solar Power Generation in India - Possible Locations