1. INTRODUCTION

Our country is facing a number of problems on power generation. The original target of increasing the generating capacity by 30,000 MW during eight plan got reduced to 20,000MW and fears are now being expressed about by achieving even this reduced target. This is ascribed essentially to a lack of sufficient financial resources. Privatization of generation with a view to attracting private investors, Indian and Foreign countries is now considered a remedy to overcome this difficulty.

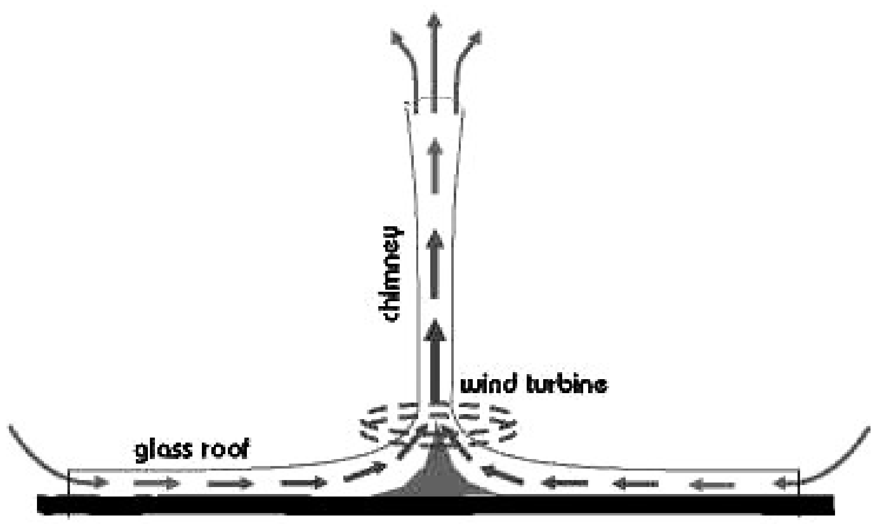
There has been some progress in this direction but for away from our expectation. Thus foreign investors like AES transpower in Orissa. Enron – in Maharashtra and siemens – Torrent in Gujrat. The process of involving foreign enterprises in the power sector has been long and arduous. Meanwhile, the load demands are increasing fast while the addition to generating capacities are slow and reliability small and the reliabilities and quantity of power supply are deteriorating resulting in frequent interruptions and low voltage thus affecting industrial and agricultural production and causing inconvenience to the public in a variety of ways.

Hence solar and wind power generation adds large extent of power generation in the target of achieving requirement. It does not consume any type of fuel, coal or any other natural resources and it does not polluted atmosphere by exhausting poisonous gases in the atmosphere, it works on simple principle only conversion of one form to another form and rotates the turbine and gives electrical output.

2. SOLAR chimney technology

How it works :-

Solar chimney work on the simple principle that hot air rises. A tall chimney is built in the centre of a large transparent solar collector. The sun rays will heat the air beneath of the collector and the warmed air, becoming less dense, ascends through the chimney. The rising hot air will become denser and draw up more air in the same fashion as a tall chimney. A turbine and electric generator can also be added to produce electricity.



Basically solar chimney power plant is the combination of solar and wind energy. In which solar energy is used to heat the air and making air less dense, which moves up with particular velocity and rotate the wind turbine.

Ambient air is drawn into the glass collector. This is warmed by solar energy and rises up the chimney. The current of rising warm air drives a turbine and the turbine is set at the base of chimney and drives the electrical generator.

The solar chimney is basically hydraulic power plant, but instead of water it uses hot air. Beneath a large glass roof air is heated. It enters a vertical tube placed at the center of the roof and creates an updrawght there inside the tube Kaplan – type wind turbine with electrical generator and producing electricity.

Continuous 24 -hr operation is guaranteed by placing tight water – filled tubes under the roof. The water heats up during the daytime and emits its heat at night. These tubes are filled only once, no further water is needed.

Solar chimney power stations makes important contributions to the energy supplies in Aftrica and Asia, because there is plenty of space and sunlight available there solar chimney power stations are particularly suitable for generating electricity in deserts and sun-rich wasteland. Their efficiency increase with the height of the chimney, not linearly but exponentially. For the power stations to generate electricity economically not only large glass or plastic roof surfaces are necessary, but also a very high chimney. The height is needed simple from the fact that the updraft is proportional to the height and also to make best use of the heat available.

The first solar chimney power plant was built and commissioned in 1983 in Manzanares, Spain. The project was funded by a research, grant awarded by the German federal Ministry for Research and Technology. This solar chimney was in operation for approximately seven years. The successful operation of this pilot plant led to the construction of two small-scale demonstration plants in Shri Lanka.

Solar chimneys are technically very similar to hydroelectric power stations- so far the only really successful renewable energy source, the collector roof is the equivalent of the reservoir, & the chimney of the pressure pipes. Both power generation systems work with pressure-stepped turbines, & both achieve low power production costs because of their extremely long life span & low running costs. The collector roof & reservoir areas required are also comparable in size for the same electrical output. But the collector roof can be built in arid deserts & removed without any difficulty whereas useful (often even populated) land is submerged under reservoirs.

Solar chimneys work on dry air & can be operated without the corrosion & cavitation typically caused by water. They will soon be just as successful as hydroelectric power stations. Electricity yielded by a solar chimney is in proportion to the intensity of global radiation, collector area & the chimney height. Thus, there is no physical optimum. The same output can be achieved with a higher chimney & a small collector or vice-versa. Optimum dimensions can be calculated only by including specific component costs (collector, chimney, and turbines) for individual sites. And so plants of different sizes are built from site to site-but always at optimum cost

3. SOLAR CHIMNEY components

As we see that the solar chimney consist of a solar collector, chimney and turbine and rest of the component i.e. generator, transmission is as same in other power plants. The main components in solar chimney power plant are as follows.

1. The solar collector.
2. The chimney
3. The wind turbine.

THE SOLAR COLLECTOR

By means of an absorber, a collector which can be used for space heating. Solar collector transforms about 80% of radiation energy into heat. Hot air for the chimney is produced by greenhouse effect in a simple air collector consisting only of a glass of plastic film covering stretched horizontally 2 to 6 m above the ground. Height increases only adjacent to the chimney base, so that the air can be diverted to vertical movement without friction loss. This covering admits short wave solar radiation component and retains long-wave radiation from the heated ground. Thus, ground under the roof heats up and transfers its heat to the air flowing radially above it from the outside to the chimney, like flow heater. The air temp. rise could be 35^0C in a well-designed collector. The total radius requires for 5MW, 30MW, 100MW is 500, 1000 and 1800 m respectively.

Peripheral area of the collector can be used as greenhouse or drying plants, at no extra cost and without significant performance loss. A collector roof of this kind is of long span and continuous maintenance can give service up to 60 years or more. Collector efficiency is improved as rise in temp. decreases. Thus, a solar chimney collector is economic, simple in operation and has a high-energy efficiency level.

OPTICAL PARAMETER OF VARIOUS GLASS ROOF MATERIALS

	GREEN	WHITE	IR REFLEX
Glass thickness (mm)	4	4	4
Long waves absorption	0. 918	0.918	0.15
Long wave transmission	0.000018	0.000018	0.000018
Short wave absorption	0.05	0.01	0.07
Short wave transmission	0.886	0.97	0.81
Refractive index	1.50	1.50	1.50
Specific heat capacity (J/kg ^{o}c)	481	481	481
Density (kg/m^3)	2580	2580	2580
Thermal conductivity (W/mK)	0.9	0.9	0.9

THE CHIMNEY

The chimney itself is the plant's actual thermal engine. It is a pressure tube with low friction and loss (like a hydroelectric tube) because of its optimum surface-volume ratio. The up-thrust of the air heated in collector is approximately proportional to air temp. rise ΔT in collector and volume (i.e. height and diameter of the chimney). In a large solar chimneys the collector raises the temp. of air by $\Delta T=35^0C$. This produces an up-draught velocity in chimney of about V=15 m/s. The efficiency of the chimney (i.e. conversion of heat into kinetic energy) is practically independent of ΔT in collector and determined by outside temp. To (lower the better) and height of chimney (higher the better).

Power = K. (Hc/To)*(Solar radiation at location)*(Area of collector)

Thus, solar chimneys can make particularly good use of the low rise in air temp. produced by heat emitted by the ground during the night and even the Meagre solar radiation of a cold winter's day!

However, compared with the collector and the turbines, the chimneys efficiency is relatively low, hence the importance of size in its efficiency curves. The chimney should be as tall as possible e.g.: at 1000m height can be built without difficulty. (Let it be remind that T.V. Tower in Toronto, is almost 600m height and serious plans are being made for 2000 m skyscrapers in earth-quake-ridden Japan.)

THE TURBINES

Mechanical output in the form of rotational energy can now he derived from the vertical air-current in the chimney by turbines. Turbines in a solar chimney do not work with stepped velocity like a free-running wind energy converter, but as a cased pressure-stepped wind turbo-generator, in which, similar to a hydroelectric power station, static pressure is converted into a pipe. The energy yield of a cased pressure-stepped turbine of this kind is about eight times greater than that of the same diameter. Air speed before and after the turbine is about the same. The output achieved is proportional to the product of volume flow per time unit and the fall in pressure at the turbine. With a view to maximum energy yield the aim of the turbine regulation concept is to maximize this product under all operating conditions.

The turbine regulates air speed and air flow by means of blade tilt. If the blades are horizontal, the turbine does not turn. If the blades are vertical and allow the air to flow through undisturbed, there is no drop in pressure at the turbine and no electricity is generated. Between these two extremes there is an optimum blade setting; the output is maximized if the pressure drop at the turbine is about two thirds of the total pressure differential available. If the air stream is throttled the air takes longer to heat up. This increases the rise in temperature in the collector. This in its turn causes increase ground storage and thus enhanced night output, but also greater loss from the collector (infrared emissions and convection). Turbines are always placed at the base of the chimney. Vertical axis turbines are particularly robust and quiet in operation. The choice is between one turbine whose blades cover the whole cross-section of the chimney or six smaller turbines distributed around the circumference of the chimney wall, here the blade length of each turbine will a sixth of the chimney diameter. The diversion channel at the base of the chimney is designed for one or six turbines as appropriate. But it is also possible to arrange a lot of small turbines with horizontal axes (as used in cooling tower fans) at the periphery of the transitional area between canopy and available technology. Generator and transmission are conventional, as used in related spheres.

In a solar chimney there are no critical dynamic loads on blades, hubs and setting equipment of the kind met in free-running wind energy converters due to gustiness of the natural wind as the canopy forms an effective buffer against rapid pressure and speed changes. This makes these components structurally simple and cheap to manufacture, and they also have a long life span.

Turbine for Solar Chimney Power Station

4. THE PROTOTYPE IN MANZANARES

Objective:-

Detailed theoretical preliminary research and a wide range of wind tunnel experiments led to the establishment plant with a peak output of 50 kW on a site made available by the Spanish utility Union Electricity Fenosa in Manzanares (about 150 km south of Madrid) in 1981-82 with funds provided by the German Ministry of Research and Technology (BMFT)

The aim of this research project was to verify theoretical data established by measurement & to examine the influence of individual component on the plant's output and efficiency under realistic engineering and meteorological conditions.

To this end a chimney 195m high and 10 m in diameter was built, surrounded by a collector 240 m in diameter. The plant was equipped with extensive measurement data acquisition facilities. The performance of the plant was registered second by second by 180 sensors.

Since the type of collector roof primarily determines a solar chimney's performance costs, different building methods and materials for the collector roof were also to be tested in Manzanares. A realistic collector roof for large-scale plants has to be built 2 to 6 m above ground level. For this reason the lowest realistic height for a collector roof for large-scale technical use, 2 m, was selected for the small Manzanares Plant. (For output a roof height of only 50 cm would in fact have been ideal.) Thus only 50 KW could be achieved in Manzanares, but this realistic roof height also permitted convenience access to the turbine at the base of the chimney. This also meant that experimental planting could be carried out under the roof to investigate additional use of the collector as a greenhouse.

HOW THE PROJECT RUN

YEAR	PROGRESS
1980	Design
1981	Construction
1982	Commissioning
1983/84	Experimental phase & structural Optimization of the roof
1985/86	In operation, further improvements to collector & electric's.
1986-89	Completely automatic long-term operation phase.

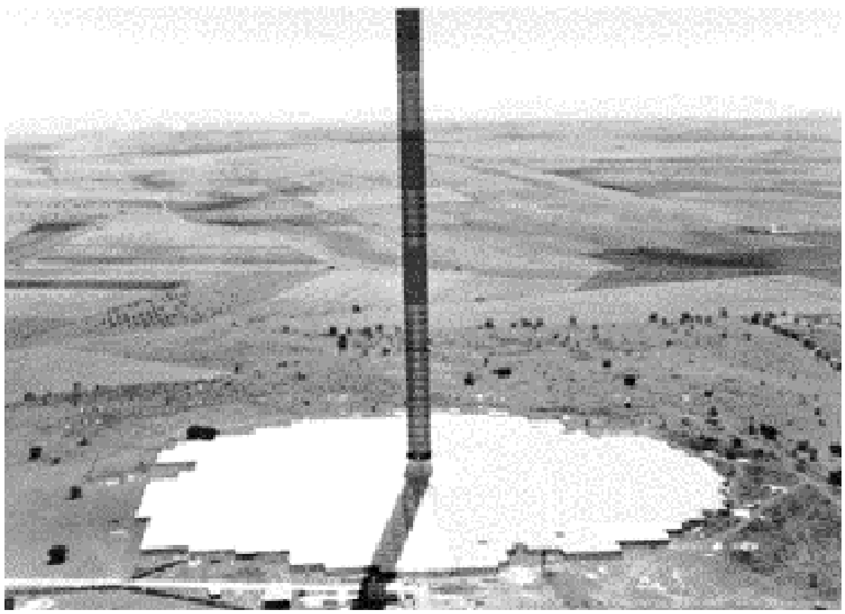
TESTS DURING THE NINE-YEAR PROJECT

The experimental plant in Manzanares ran for about 15000 hours from 1982 onwards. The following tests were run in the course of the projects :

- Different collector roof covering were tested for structural stability, durability and influence on output.
- The behaviour of the plant as whole was measured second by second (ground temperature, air temperature, speed and humidity, translucency of the collector, turbine data, meteorology etc.
- The ground's storage capacity was tested in terms of collector temperature and soil humidity. In order to investigate heat absorption and heat storage it was in turn left as it was, sprayed with black asphalt and covered with black plastic.
- Various turbine regulation strategies were developed and tested;

- Maintenance and running costs for individual components were investigated;

- The thermodynamic plant simulation program developed in all details in the mean time was verified with the aid of the experimental results and accompanying wind tunnel experiments, in order to make reliable calculations for any individual site data, meteorology and plant dimensions for daily & annual energy production by large solar chimneys.



THE PROTOTYPE PLANT IN MANZANARES

TYPICAL PLANT OPERATING PARAMETERS FOR PLANT OF RATING 5,30 AND 100 MW ARE GIVEN IN TABLE

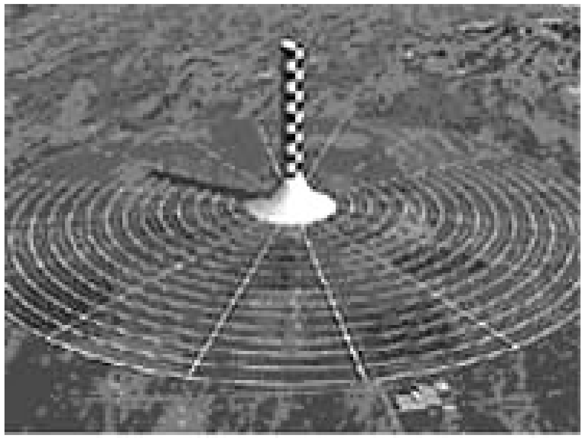
	5 MW	30 MW	100 MW
Civil Engineering			
Chimney height (m)	445	750	950
Chimney radius (m)	27	42	57.5

Collector radius (m)	555	1100	1800
Collector height, external (m)	3.5	4.5	6.5
Collector height, internal (m)	11.5	15.5	20.5
Mechanical Engineering			
Type of turbine	Propeller Type		
Number of turbine	33	35	36
Distance of turbine from Chimney Centre (m)	53	84	115
Airflow rates (m/s)	8	10.4	13.8
Shaft power rating of Individual turbines (KW)	190	1071	3472
Blade tip-to-wind speed ratio	10	10	8
Rotational speed (1/min.)	153	132	105
Torque (kNm)	11.9	77.5	314.5
Operating data at rated load			
Upward air draught speed (m/s)	9.07	12.59	15.82
Total pressure difference (pa)	383.3	767.1	1100.5
Pressure drop over turbine (pa)	314.3	629.1	902.4
Friction (N)	28.6	62.9	80.6
Temperature in collector (°C)	25.6	31.0	35.7

Thus the successful operation of this pilot plant led to the construction of two small-scale demonstration plants in Shri Lanka, Australia and India.

IN AUSTRALIA

In Australia at Melbourne the world's tallest Man made structure could soon be towering over the Australian outback as part of a plan to capitalize on the global push for greater use of renewable energy. Mainly the team at Manzanares works with this plant combining Enviro-mission.



An artist's rendition of the solar chimney.

Australia power company Enviro-mission ltd. hopes to build a 1,000 meter (3,300 feet) solar tower in south west new South Wales state, a structure that would be more than twice the height of Malaysia's Petron's Towers, the world's tallest building. The plant having seven kilometer roof diameter and 1 km chimney height, and a 3 meter distance at outer periphery and 25 m distance at inner periphery of solar collector roof. And which it allows to sucked hot air through 32 turbines which generate power 24 hrs a day having output expected to 650 GW/yrs.

IN INDIA

A 200 MW power plants is being built at Thar (Jaisalmar) by a consortium of Shri Lanka and Germany at the cost of Us $ 450 billion which is going to commissioned in year 2005 according to Rajasthan Energy Development Agency (REDA)-

5. Advantages of SCPP

The advantages of SCPP are as follows.

1. It provides electricity 24 hrs a day from solar energy alone. At night, heat absorbing or other sources in the "green house" would slowly release the thermal energy built up during the day, maintaining the indoor-outdoor temperature differential The solar chimney can operate around the clock,

instead of depending on environmental factors such as the wind needed for wind farms.

2. No fuel is needed, it needs no cooling water and is suitable in extreme drying regions, it is practically reliable and a little trouble – prone compared with other power plant. The material concrete, glass and steel necessary for the building of solar chimney power stations are everywhere in sufficient quantities.
3. It does not exhausting poisonous gases or smoke as in thermal power plant. It does not utilizes the sources of energy it does not unbalance the natural phenomenon.
4. As in hydroelectric power plant due to storage of water the lack of water to agricultural land may arise problem of agricultural fields. This type of problem is not arises in solar chimney power plant.
5. It can use the infertile land for the construction such as desert land which will cause to progress in that area.
6. The peripheral area of collector is used for the greenhouse cultivation for drying plants.

6. CONCLUSION

From the above discussion this paper would like draw following conclusions.

1) The collector of solar chimney plant can use all solar radiation both direct and diffused. So, this plant technique is also helping hands to those countries where the sky is frequently overcast.

2) There are many regions in country which are deserts and soil don't bear any crop. And thus no contribution to mankind. But installing plant there give excellent results.
3) The technology and the material to build such plants are available in the country. Hence, such power plants are very attractive in India for bulk power generation even in deserts. The capital cost is high, nearly 7 crore/MW, which can be reduced. However, the cost of generation could be as low as Rs.1.62 per KWH in long run.

Hence due to various advantages now most of the country are attracting towards the generation of power by using solar chimney power plant techniques.

References

1. "Prof. B.S. Magal" , "Industrial products finder " ,July 1996
2. "Solar Power Engineering" Tata -McGraw Hill Publishing Co Ltd , New Delhi (1994) By: Prof. B. S. Magal
3. "Arora, Domkundwar", Power plant Engineering .

4. http: // www.active word.com/energen

5. www.google.com