DIRECT APPLICATION OF GEOTHERMAL RESOURCES IN INDIA: A CONVENTIONAL GEOTHERMAL SPECIALITY

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Abstract

Geothermal resources, believed to have been created by faults in the evolution of earth, are God's gift which we realised only recently. **India** too has been blessed with a reasonable quantum of geothermal resources and with the growing need for energy in India, geothermal resources for direct application should be developed.

Geothermal sources exist in most parts of the world and direct applications offer tremendous opportunities for improving the economy in rural areas where infrastructure for power distribution may not be very good. It is to be noted that where the fluid temperature is high, cascade use with power production followed by direct application and subsequently by use for even tourism purposes, like some examples in Iceland. The New Zealand Geothermal Association should play an important role in propagating insights on conventional uses of geothermal energyto the rest of the world and with New Zealand – India vision 2015, the two great nations can take the geothermal world by storm. The clean energy vision of the world powers has moved into the directions of solar, wind and other forms and its time to push the time-tested eco-friendly geothermal sources of energy. Further this strategy would also help with better management of these resources and help preserve them for future generations.

The energy hunger of the world economic powers has resulted in irreparable damage to the environment and since World War II the damage has been rapid and corrective steps seem to start and then come to a stand-still. Conventional geothermal has proved by the test of time and I advocate the direct use of geothermal resources to reduce the burden on other forms of energy use, particularly for power generation, as much as possible.

INTRODUCTION

India began to investigate geothermal energy during the late 1960s when a committee was constituted to study the hot springs in India to understand the potential for power generation and other uses (***but it is note worthy to mention that the earliest exploration of the geothermal resources of India was in 1905***). The report of the committee, submitted in 1968 (ref), laid the foundation for further work in the geothermal sector and experiments led to the Geological Survery of India embarking on geothermal exploration and development on a pilot scale in 1973 with the lauch of the Puja project in Jammu & Kashmir (ref). But there has been no major breakthrough in the exploitation of India's geothermal resoruces though there have been projections made of a power production potential of almost 10900 MW (ref). However, it has been further debated that the realistic target should be about 300 MW in power generation (ref), but more interest in the direct applications of geothermal resources has recently developed.(ref).

The objective of this paper is to discuss the unique dimensions of the geothermal industry in India. In particular:

- The use of geothermal resources for direct applications to reduce the strain on the electric grid
- How to provide geothermal energy to sections of rural India which always bear the brunt of shortages of electricity.

India is home to about 340 low – high enthalpy hot springs across the country (ref) and I attempt to elaborate the possibility of using these heat resources on the basis of Lindal's philosophy of direct use of geothermal resources (ref).

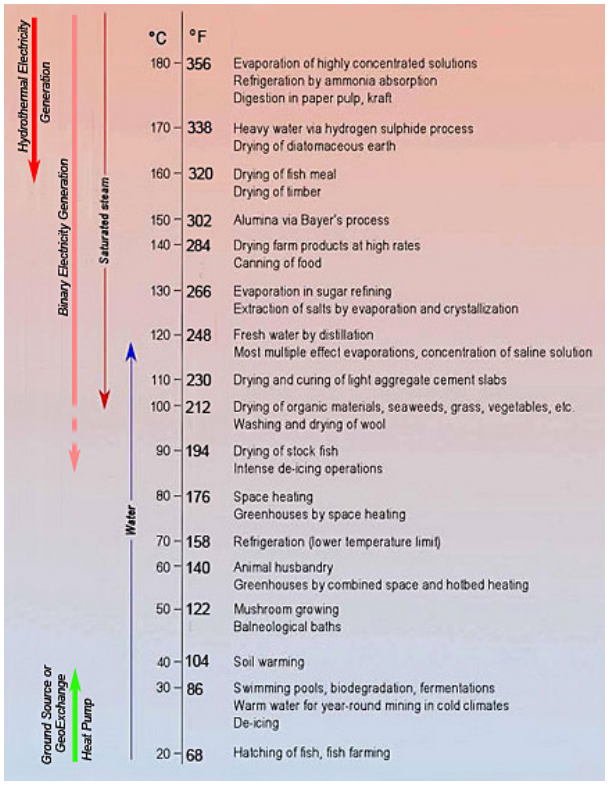

Figure 1 : Lindal thoughts on direct application

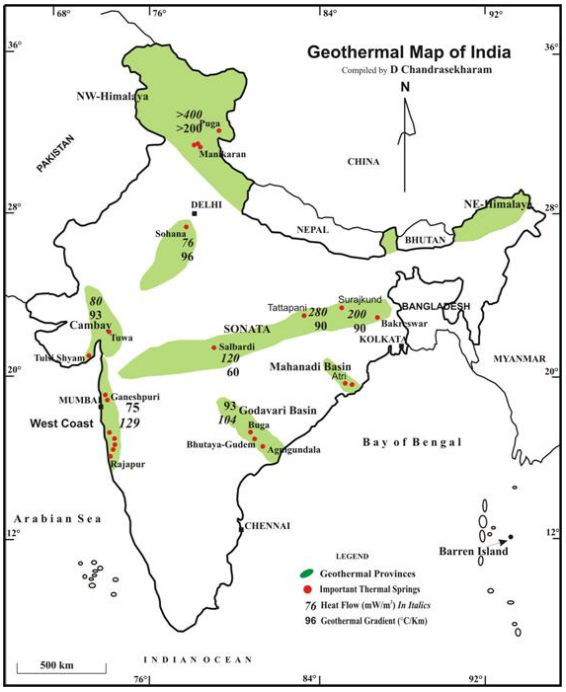

Figure 2: Geothermal Map of India by D. Chandrasekharam

The ground has been laid by a few organisations in space cooling and heating or water heating but the potential to increase the use of the resource is still wide and all the possible applications are discussed below.

1. TOURISM & BALNEOLOGY

Tourism has the potential to increase India's forex inflows by creating better infrastructure in places of interest for tourists. The matter needs further investigation as not only an increase in foreign exchange revenue from inbound foreign tourists but also a reduction of foreign exchange outflow by domestic tourists spending outside India may occur if better domestic travel destinations are available. So far the **Incredible India** campaign has made little impact in increasing the number of international tourists (ref)and also there has been a steady increase in Indians touring outside India spending their disposable incomes, thus making a dent in the overall balance of payments (ref).

India is the home of Ayurveda (ref) and Balnelogy is not new to Indians and baths have been built by the Royal familes close to the hot springs for their personal use. The water from the geothermal springs are not soothing to tired limbs, the cult of "taking the water" is traced centuries back.

The water is alleged to possess healing properties (even for incurable diseases), induce fertility in women and have several mystic effects on mankind when applied externally or resulting from bathing in these waters.

The example of Iceland is note worthy; it is called the ***Geothermal Disney*** of the World and an increase of tourism into Iceland has resulted from sheer focus on their geothermal assets. The challenge for India – Government as well as the operators in the industry, is to understand the presence of the over 340 hot springs and develop boutique green facilities around the most prominent hot springs and create the basis for organised geothermal tourism in India.

Though there has been some effort made by the state machinery nevertheless a careful study of the experiences of Iceland, New Zealand, USA, Japan and Australia should be made.

The current areas of focus are listed below:

- Sohna district in Haryana
- Unkeshwar & Ganeshpuri (also a pilgrimage centre) in Maharashtra
- Bakreshwar in West Bengal
- Surajkund in Bihar

- Beas, Kullu, Manikaran in Himachal Pradesh.

But the best strategy is to break the barriers of unorganised tourism and create a green platform for organised geothermal tourism in India. India is blessed with quite a few wonderful hot springs which are closed to world recognised pilgrimage centres.

Other prominent areas that could be focussed on are:

- Jammu and Kashmir (Puga valley, Leh)
- Arunachal Pradesh
- Sikkim
- Uttarakhand.

The North Eastern states have not had their fair share of priority in the Indian political history and an influx of increased revenue from tourism may prompt better linkage to these states and give them their due.

2. DISTRICT (HOT) WATER SUPPLY

Experiences from studies in Iceland, Turkey and New Zealand show the use of water from these natural springs is suitable for consumption, in most cases with just mild distillation. Water from these springs is bottled in most countries where these sources exist and in some cases the use has been in practice for long periods.

The water drawn can be checked for its chemical composition and based on the results the water can be directly used or treated to remove chemicals (or impurities) and then run into the distribution network. Recently, commercial exploitation of geothermal sources have been used to supply hot water for bathing and washing uses. Geothermal India has installed systems in Apollo Hospital in Chennai and Hyderabad to supply hot water through the pipelines 24 x 7 and the results in terms of constant water supply as well as savings in power has been substantial as reported by the team (ref).

3. SPACE HEATING / COOLING

Electricity use in urban India and the changing rural areas have seen rapid growth and space cooling by air-conditioners has been a major reason for the change. Global warming has had serious impacts on the seasons and most parts of India have seen severe drought and the average temperatures have soared by 2-3 degrees in the last 3-4 years.

Geothermal pumps and heat exchangers can be easily deployed to reduce the need for air-condtioners. The reduction in use of air-condtioners will not only help save electricity but work towards better space conditioning as the equipment uses dangerous gases (in most cases) and while the space is conditioned the immediate outside environment is heated causing further damge to the environment.

The Indian School of Business has worked with GIBBS, a leading player in the Indian scene for space cooling and water conditioning through geothermal sources.

This is one of the best potential uses of geothermal energy in urban India as low enthalpy resources can be exploited in close proximities to the work-place with these energy efficient systems. The growing acceptance for Green buildings will pave the way for better acceptance of geothermal systems and the stress will come on the Renewable Energy Ministry, which has earlier subsidised solar, wind and bio-mass alternatives, to prepare a geothermal policy and work towards better utilisation of the geothermal resoruces.

A special mention is required for space heating which might be a critical missing link for the Armed Forces in Jammu and Kashmir. Indian soldiers work and live in the most horrendeous conditions in the world's highest battle ground – the Siachen sector, and the use of the geothermal resources in the state could be a good solution for creating better living standards. The geothermal resources could be used not only in space heating but also for cooking in conditions with temperatures recorded as low as – 50 ° C.

4. FARMING & AQUACULTURE

India's economic strength used to be its farming community but with rapid industrialisation since the late 1980s the contribution of our farmers has reduced and our dependency on imported food grains, vegetables and fruits is increasing annually.

4.1 Greenhouses

Internationally geothermal resources have been used effectively in green house based farming (ref) but in India there has been limited success in the exploitation of this technology. The Indian agricultural community has been predominantly an unorganised sector and very little change has

occurred over the years. The situation has been further complicated with families moving towards urban locations and land holdings have been partitioned or sold and little new age technologies have been applied in farming. The farmers are dependent on the local weather conditions, including water, and cultivation has been region specific and so is the availability of vegetables and fruits.

Geothermal greenhouses have been on the rise in parts of United States, Europe, Asia and Africa but with limited growth in India. Each plant can be considered as a chemical factory, with the main technology employed being photosynthesis, and the energy stored in the plants acts as the building material for its growth. In order to complete a full life cycle, each type of plant needs a specific quantity of energy (that is heat) and the duration of its development, quantity and quality are governed by the quality and density of energy supplied to the plant, which in turn is correlated to the intensity of the light available. The operation of a greenhouse works towards controlling the parameters that help optimise the situation for growth. The parameters are:

- Light
- Temperature
- CO2 concenteration
- Air movement
- Water transport
- Soil temperature.

Experimental production of plants and flowers has been initiated at Chumathang Valley. Temperatures of 20-25 Deg. C can be maintained in the green house enclosure compared to the -40 Deg C in winter in the valley.

The West Coastal belt in India has the potential for large scale production of vegetables and fruits utilising the greenhouse techniques to keep cost of these products under control and also create better opportunities for the small farmers in the region.

4.2 Cold Storage

India's consumption of vegetables and fruits have been very low compared to the world average as the infrastucture to support the movement of the produce is still not adequate. The establishment of a better road network has been the main focus of the Government and there is some stress on the enhancement of railway network, but the focus on improvement of cold storage facilities has been limited. The establishment of cold storage facilities has been a private industry business based on a profit motivation. The establishment of common cold storage facilities has been neglected and with the production of farm products in largely rural areas the access to the markets becomes difficult and either produce perishes or attracts low prices making farming unviable for small farmers.

Cold Storage powered by geothermal resources have been attempted in India with a 7.5 tonne plant established in Manikaran (Parbati valley) based on an ammonia absorption system but not much has been done to deploy geothermal energy to create better infrastructure in warehousing, especially in the rural areas. The lower operating costs of geothermal plants should prompt the Government to support establishment of cold warehouses for the regional farmers and this would result in reduction of wastage of agricultural produce.

4.3 Aquaculture

India's fishing industry has predominantly been based on the fishing villages established in the coastal areas and the communities living close the river banks for fresh water fish. Experimentation with the growing of shrimps was undertaken in Andhra Pradesh and Orissa with commercial success based on the use of small tanks. But geothermal sources have the potential to keep the water temperature under control, thus creating a low cost environment for better growth of the aquatic life.

Geothermal activity, which is spread across most of India, can be effectively utilised for creating a livelihood for the communities living close to the identified springs.

5. INDUSTRIAL APPLICATIONS

Energy requirement in India has increased due to the continous industrialisation since Independence though with more social capital during first 2-3 decades and the pace has increased since the mid 2000s (ref). The presence of mostly low enthalpy geothermal sources calls for establishment of industrial activity close to the source as heat energy cannot be transferred over long distances as there would be significant losses. In the past the location of industries has been based on availability of raw material or availability of adequate land as the marketplace is considered to be world-wide. Therefore relocating manufacturing plants close to the geothermal activity should not be a difficult task as energy is one of the major constituents in many industries.

The industries that can be considered for relocation are:

- *Pulp and paper mills*

- *Fibre production processes* (viscose in particular) that need electricity as well as heat energy

- *Alcoholic beverage production*

- *Food processing*

Geothermal energy in most cases cannot be used directly in food processing due to the presence of minerals / chemicals in the composition of the fluids / steam. However, experience have shown that the extra minerals / chemicals can be removed prior to actual utilisation of the energy for food processing and the ***extracted*** chemicals / minerals can become a bye-product of the industry (ref).

Potato in one of the most highly processed ingredient in the food supply chain. Over 40% of the potatoes produced in the world are processed into various products and geothermal energy can be used for complete processing: from cleaning to peeling to finishing. Low enthalpy energy sources can provide about 30% of the energy requirement and in case of higher temperature resources of about 200 deg. C, it might provide almost 90% of the energy requirement.

Other areas of food processing that could be focussed on are:

a) cane sugar production
b) sugar beet manufacture
c) production of instant coffee
d) production of milk powder
e) dehydration of vegetables & fruits
f) fruit juice production & packing
g) freeze drying of foodstuffs
h) rice parboiling
i) fish drying & meat processing

- *Waste water treatment* (as the heat requirement is high)

6. MINERAL PRODUCTION OR EXTRACTION

The Geological Survery of India has conducted preliminary tests of the Indian hot springs to consider mineral exploration and extraction as a major development area in the utilisation of geothermal sources. Geothermal springs are believed to contain path finder minerals and sulphur. Enthalpy and radon gas emission can be used for exploration of gold, silver and heavy radioactive minerals. The most common of them being bulk minerals like sulphur, borax and mercury. The other minerals of economic value that receives considerable attention are gold, caesium and lithium.

Boron and sulphur can be extracted, particularly in Jammu and Kashmir, with volumes predicted to be worth the attempt. Gold and silver extraction was attempted in India in Uttar Pradesh and Himachal Pradesh with limited success as the presence of the metals was minimal but in the future when the prices of these metals rise, the process may prove to be economically viable.

But the viability of the mineral extraction may already be proven. Puga (in Jammu and Kashmir) and Chuza in Himachal Pradesh have high content of caesium as studied and reported by the GSI (ref). Preliminary studies for extraction have been initiated at Chuza as well a Puga. However, its pertinent to note that Puga is a unique geothermal formation and can be India's geothermal hub. There temperatures have been observed as high as 200 deg. C and it is expected to be the best source for the production of electricity (up to 100MW). The fluids / heat energy post production of electricity can be used for direct use. Caesium has good marketability in the world and Puga springs are estimated to discharge 10 tons of caesium into the nala and it is subsequently replenished through the fresh discharge.

It is also reported that the Chuza thermal springs contain about 20ppm of lithium in its fluids. Even at 5ppm content the extraction of lithium is widely carried out in Japan and therefore Chuza offers an amazing potential for development of the much sought after high powered lithium batteries in India itself.

Apart from the above mentioned possibilites, the other possibilities include cooking in the rural areas (in Bihar & Orissa), silviculture (Kosa silk in Madhya Pradesh as no processing plants are available for want of electricity), fibre processing (nettle in particular; Sikkim and Uttarakhand produce this magical fibre but cannot be brought into the commercial fibre industry as there is little or no electricity available in the areas of cultivation), making hard boards in the areas of production of the fibres to help local farmers /

entrepreuners earn a better livelihood from these currently rural areas.

CONCLUSION

Research findings identify the utilisation of the geothermal resources of India as a potential major support for rural India, but with the data available being old, exploration to document the present status is required before utilisation can be planned. The Indian experts who have done work in the geothermal sciences have moved on in search of better prospects as the scope for development of geothermal resources in the rest of the world have interested them. At least a few of them would have to be called in to help with the exploration and utilisation of geothermal resources in India. In addition to this, it would be useful to seek collaboration with international agencies specialising in geothermal science and technology to recommence the exploration either in collaboration with Governmental agencies or private players. The whole process would have a better start if the Government comes out with a Geothermal Policy and ensures a push for the use of this renewable energy. It could reach the popularity levels of solar and wind in a short time. It is the initial cost of exploration and research which is stopping investors from looking at this God's gift as a real potential. Input from the University of Auckland, GNS and NZGA is critical for creating India's geothermal path and the New Zealand's India Vision 2015 philosophy rolls out the red carpet for the collaboration.

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