# Harnessing potential of Geo Thermal Energy for climate control in Running Rooms, Rest Houses, Office Building etc.

## Concept Note

**Introduction:**

Geothermal (or earth heat) energy is the heat stored in earth crust. Although ambient or surface temperature at any place has wide seasonal variation, the temperature beneath the earth at 7-8 meter remains constant throughout the year at roughly equal to the mean annual air temperature at that latitude at the surface. For example, surface or ambient temperature in Delhi varies from 4-5 degree C in winter to 42-47 degree C during summer, however, temperature at 7 meter below surface remains constant at about 25-26 degree C throughout the year.

Geo Thermal Energy (GET) system utilizes this feature by using the earth as a heat source (in the winter) or a heat sink (in the summer). GET systems are becoming widely adopted in developed World, particularly in the USA, Canada, Sweden, Switzerland and Germany as they provide a proven, cost-effective, safe and environmentally friendly alternative to fossil fuels.

In India, Geo Thermal Energy system are also becoming popular in temperature control and/or air conditioning systems in large office buildings (e.g. Office of Min. of Environment & Forests, Govt. of India, Jorbagh, New Delhi), academic complexes ( TERI University, New Delhi) as well as in individual residential units.

Generally, Earth Air Tunnel (EAT) or Ground Source Heat Pump (GSHP) technologies are deployed to harness geo thermal potential.

**Earth Air Tunnel (EAT):**

**Principle:**

Earth Air Tunnel (EAT) is a technique in which air to sub-soil heat exchange occurs in buried pipes for producing cooling in summer and heating in winter.

During winter, the ambient temperature (e.g 4-5 degree centigrade) becomes much lower than sub soil temperature (25-26 degree centigrade). Heat is absorbed by circulating from relatively warmer earth's sub-surface and then transferred to the building for room heating.

During summer, the sub soil temperature remains about 10-15 degree lower than ambient temperature. The continually circulating air in the buried pipes 'picks up' heat from the building and transfers it into the relatively cooler earth.

EAT can be either closed loop or open loop cycle. In closed loop cycle, interior air circulates through EATs while fresh air can be added based on need.

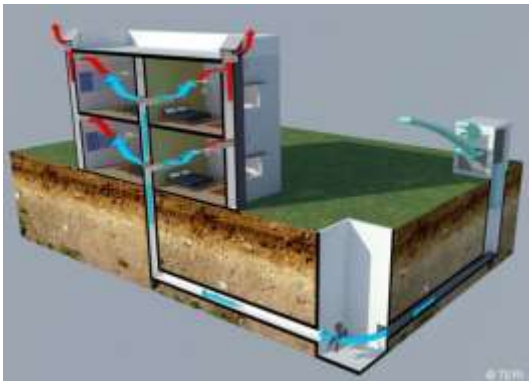

Figure-1: Open Loop Earth Air Tunnel System
(Souce-TERI, New Delhi)

In open loop system, Outdoor air is drawn into EAT and delivered to the inside of the building. Hot air from inside of the building is exhausted through solar chimney. Illustration of an open loop cycle is at Figure-1:

**System Design:**

Earth tunnels of about 100-120m are normally dug at a depth of 6-8m and HDPE/concrete pipes of 450-500mm diameter are placed inside these tunnels and earth is filled in. Generally, one tunnel with 3 (three) pipes inside is required to cater to 5-6 normal size rooms (12 ft X 12 ft).

One end of the pipe systems is exposed to atmosphere whereas other end is connected to Air Handling Unit (AHU), which in turn, distributes air to rooms after suitable humidifying or de-humidifying.

Hot air from rooms is purged out through normal draft achieved by installing solar chimney in each room.

**Advantage:**

EAT system can replace dessert coolers in summer and room heater during winter. It is also noise free and does not need regular water topping in cooler. The power consumption is minimal as only the AHU will draw electric energy. For places where power disruption is common, the AHU can be powered through Solar Photo Voltaic Cell.

EAT systems are practically maintenance free. When installed properly, the buried pipes last for 40-50 years. The moving units, that is, the AHU is housed indoors and thus easy to maintain.

**Limitations:**

Although, the average sub soil temperature remains at 25-28 degree centigrade, during peak summer, when ambient temperature rises above 45 degree centigrade, the room air temperature may rise to 30-31 degree centigrade[1].

Sufficient ground space will be necessary for digging multiple earth tunnels of 120m long for installing the system.

**Estimated Cost:**

Estimated cost for installing ETA system for cooling/heating will be about Rs. 1.5 lakhs per standard room (12 ft X 12 ft ). Thus, for a 20 room hostel/running room, total cost of installation will be about Rs. 30 lakhs.

**Success Story:**

Earth Air Tunnel (EAT) is operational at 32 room hostel, TERI University Campus, New Delhi[2].

[1] Empirical Data, TERI University, New Delhi (in the month of June), Dr. Pradeep Kumar, Senior Fellow, TERI
[2] -do-

**Ground Source Heat Pumps (GSHP):**

**Principle:**

Ground Source Heat Pumps (GSHP's) work on the principle of "refrigeration cycle". The system comprises of (i) buried pipes that circulates working fluid (water +antifreeze), (ii) heat pump with evaporator & condenser and (iii) forced air flow system. The forced air system will supply air to rooms via ducts. The schematic diagram is depicted in Figure-2.

During winter, sub soil acts as heat source and heat is transferred through the buried pipes into the circulating liquid (water, or a mixture of water & antifreeze) and then transferred again into air through heat pump for room heating. During summer, sub soil acts as heat sink and continually circulating fluid in the pipes 'picks up' heat from air through heat pump and transfers it into the earth.

Attaching appropriate equipment, GSHPs can also be used to heat water for use during winter season. GHSP's can be operated on 24X7 basis.

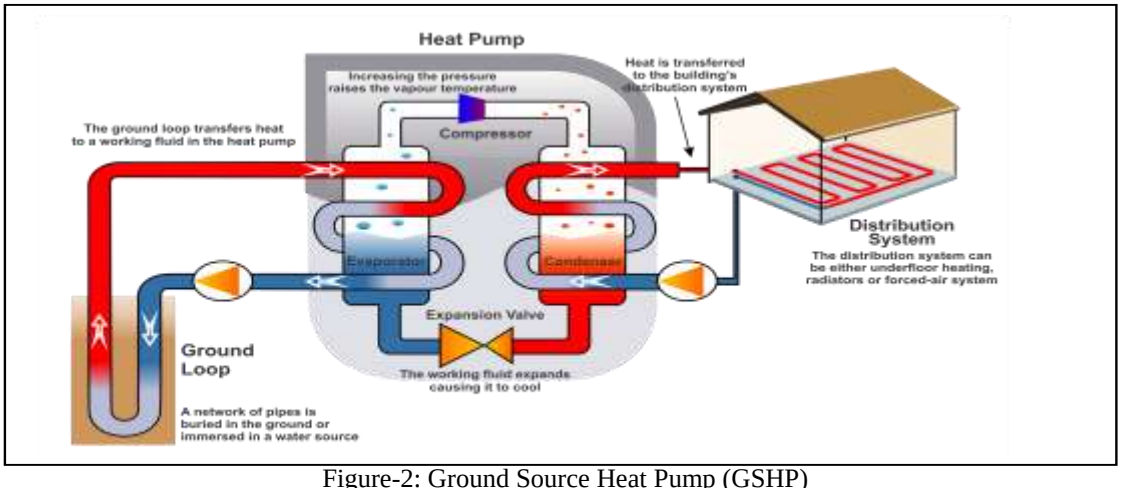


Figure-2: Ground Source Heat Pump (GSHP)

In a nut shell, GHSP acts as air conditioning system with sub-soil acting as heat source (during winter) and heat sink (during summer).

**System Design:**

The system comprises of HDPE pipes that are laid in vertical, horizontal, pond or slinky (helical) pattern in trenches depending upon space available. (Figure-3)

The trenches are dug at 4-6 meters deep to harness a consistent year-round heat source/sink. About 50-80 meters of pipe is required to be laid per tonnes of refrigeration load. One standard room (12 ft X 12 ft) approximately needs about 0.8 to 1 tonne of refrigeration.

In case of helical laying of pips, around 40 square meter of ground area will be needed for catering to one standard room. If


Figure-3: Pattern of ground pipes

horizontal space is not available, boreholes of vertical design may be adopted. One borehole of 100-150m deep can produce about 3-4 tonnes of cooling/heating.

**Advantage:**

GSHP system can replace air conditioning system in residential/office complexes. GSHP can maintain even 18-22 degree centigrade room temperature when ambient temperature is more than 45 degree centigrade. On the other hand, the system can also maintain 25-26 degree centigrade room temperature during peak winter seasons.

GSHP brings down electric consumption by about 50% than normal air conditioning/heating systems. Thus, the estimated payback period of such system is estimated to be 3 to 4 years after that it can be used for another 30 year free of cost[3].

GSHP systems are practically maintenance free. Usually, maintenance involves only periodic checks and filter changes and costs less Rs 0.2 /Tonnes of refrigeration.

**Limitations:**

The heat pump and AHU needs external power to operate (about 500-600 watt per tonne of refrigeration). Thus the system is not recommended in areas where electric power supply is intermittent.

**Estimated Cost:**

Estimated cost for installing GSHP system is about Rs. 1.25-1.5 lakhs per standard room (12 ft X 12 ft ). Thus, for a 20 room hostel/running room, total cost of installation will be about Rs. 25-30 lakhs.

**Success Story:**

GSHP is operational at the office building of Min. of Environment & Forests, Govt. of India located at Jorbagh, New Delhi.

**Use of Geothermal Energy in Railway Running Rooms, Rest Houses, Office buildings etc:**

Geo Thermal Energy has emerged as one of the most efficient residential heating and cooling systems available today with higher heating and cooling efficiencies than available air conditioners/room heaters. Selection of technology will primarily depend on end user need. For example, ETA system will be preferred if end user need is dessert cooler/room heater, whereas, GSHP system will be necessary to replace air conditioning/room heating units.

Cost of the installing geo thermal system (EAT & GSHP) is also site specific and depends of availability of space for trenching/putting air pipes or water loops. However, whatever technology is selected, payback of such system is between 3-4 years after which it can be used almost free of cost for another 30-40 years.

Geothermal Energy presents immense potential to Indian Railways by adopting the technology at Crew Running Rooms, Office buildings (DRM & GM Offices), Rest Houses (Rail Niwas, New Delhi) etc. for power saving and promoting clean and renewable energy.

[3] Source: Ministry of New & Renewable Energy, Govt. of India