Energy is necessary for all activities in and around us. Energy provides comfort, increases productivity and allows us to live the way we want to. At present most of our energy demand is met by the energy obtained from conventional fossil fuels such as coal, petrol, diesel, natural gas, kerosene etc. It is estimated that we could run out of oil in about 40 years and of natural gas soon after. Not only are fossil fuels running out, but they're adding to our environmental problems by releasing harmful

This geothermal power plant in Reykjavik, Iceland, is using its underground reservoirs of steam and hot water to generate electricity and to heat and cool buildings directly.

Geothermal energy is one of the potential alternative energy sources catering to both industrial and domestic energy requirements in many parts of the world. Presently, it is being used as a source for producing electricity mainly along active plate boundaries.

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byproducts that increase pollution and contribute to global warming. In view of the limited store of fossil fuels and ever increasing gap between the demand and supply of energy, it is necessary to switch to new and renewable sources of energy. It is a fact that India has one of the highest potentials for effective use of renewable energy. During the last one decade, there has been a visible impact of renewable energy in the Indian energy scenario. Apart from contributing to about 12.5 per cent in the national electric installed capacity, renewable energy based applications have benefitted millions of people in the Indian villages by providing for their energy needs in an environment friendly manner. India is the world’s fifth largest producer of wind power after Denmark, Germany, Spain, and the USA. Other renewable energy technologies, including solar photovoltaic (PV), solar thermal, small hydro power, geothermal, sea wave and biomass energy are also spreading. As greater reliance on renewable energy sources offers enormous economic, social, and environmental benefits, we need to explore more sources of renewable energy. Geothermal energy is one of the renewable sources of energy available in the form of vast natural reservoirs of heat energy in the earth’s interior. A number of geothermal power plants, which generate more than 10,000 MW power are operational in at least 24 countries of the world. Besides, geothermal energy is being used directly for heating in at least 78 countries. The largest producer of this energy is USA that generates about 3,086 MW of electricity.

WHAT IS GEOTHERMAL ENERGY?

Geothermal energy is one of the potential alternative sources of energy which has been successfully catering to both industrial and domestic energy requirements in many parts of the world over the last few decades. Geothermal is made of two Greek words – geo which means ‘earth’, and therme, which means ‘heat’. Thus, geothermal energy is the heat from the earth. It is a clean and sustainable source of energy. Resources of geothermal energy range from the moderate-to-low temperature hot spring systems to hot rock found a few miles beneath the earth’s surface, and down even deeper to the extremely high temperatures of molten rocks. Below the earth’s crust, there is a layer of hot and molten rocks called magma. Heat is continually produced there, mostly from the decay of naturally radioactive materials such as uranium and potassium. Heat flows outward from the earth’s interior. Normally, the crust of the earth insulates us from earth’s interior heat. The mantle is semi-molten, the outer core is liquid and the inner core is solid. It is interesting to mention here that the amount of heat within 10,000 meters of earth’s surface is 50,000 times more energy than all the oil and natural gas resources in the world.

In fact, geothermal energy is one of the oldest natural sources of heat and dates back to the Roman times, when the heat from the earth was used instead of fire to heat rooms and/or warm water for baths. Presently, it is being used as a source for producing electricity, mainly along plate margins.

HOW IS GEOTHERMAL ENERGY CAPTURED?

Now, the basic question is how do we use geothermal energy for the benefit of mankind? Normally geothermal energy is captured from geothermal hotspots. Basically, a hotspot is an area of reduced thickness in the mantle which allows the excess internal heat from the interior of the earth to flow to the outer crust. These hotspots include the volcanic islands, mineral deposits, and geysers normally known as hot springs. Following are some ways in which heat from these geothermal hotspots is obtained.

**Hot Springs for Geothermal Power Plants**: The most common way of capturing energy from geothermal heat is to tap into naturally occurring ‘hydrothermal convection’
systems where cooler water seeping into earth’s crust is heated up, and it then rises to the surface. When heated water from the hot springs is forced to the surface, it is a relatively simple matter to capture that steam and use it to drive electric generators. In order to set up geothermal power plants, holes are drilled into the rock to capture steam more effectively to drive electric generators. If the water comes out of the hot spring as steam, it can be used directly whereas the hot water can be used as a flash system.

**Direct uses of Geothermal Heat:** Geothermal reservoirs of hot water, which are found a couple of miles or more beneath the Earth’s surface, can also be used to provide heat directly. This is called the direct use of geothermal energy. Direct use of geothermal energy is a very old method when people used hot springs for bathing, cooking food, and other day to day heating purposes. Besides, the hot spring water was used to heat greenhouses, fish farms and spas, to dry fish, de-ice roads, and improve oil recovery, and to heat. But now, modern systems are being used for direct-use in which a well is drilled into a geothermal reservoir to provide a steady stream of hot water. The water is brought up through the well and a mechanical system - piping, a heat exchanger, controls, which delivers the heat directly for its intended use.

**Ground-source heat pumps:** It is found that the temperature of the upper 10 feet of the earth is nearly constant - between 10°-16°C. During winter this region is warmer than the air above it, whereas in summer it is cooler. In order to take advantage of this resource, geothermal heat pumps can be set up to heat and cool buildings. Geothermal heat pump systems consist of a ground heat exchanger, a heat pump unit, and an air delivery system. The heat exchanger is basically a system of pipes called a loop, which is buried in the shallow ground near the building. Geothermal heat pumps use much less energy than conventional systems, since they draw heat from the ground. A much more conventional way to tap geothermal energy is by using geothermal pumps to provide...
heating and cooling to buildings.

**Advantages and limitations of Geothermal Energy:** Geothermal energy is used for heating homes and for generating electricity without producing any harmful emissions. The first advantage of using geothermal heat as a source of energy is that, unlike most power stations, a geothermal power plant does not create any pollution and geothermal energy can be used to produce electricity 24 hours a day. Thus, geothermal energy is an excellent source of clean, inexpensive and renewable energy. If the geothermal energy is harnessed correctly, it leads to no harmful by-products. Geothermal power plants are generally small and have little effect on the natural landscape, or the nearby environment. As no fuel is used to generate the power from the geothermal heat, running costs for geothermal power plants are very low. Moreover, the cost of the land to build a geothermal power plant, is usually less as compared to the cost of constructing an oil, gas, coal, or nuclear power plant.

Though geothermal energy has several advantages, it also has certain disadvantages and limitations. If harnessed incorrectly, geothermal energy can sometime produce pollutants. Improper drilling into the earth can release hazardous minerals and gases from deep down inside the earth, which can be contained quite easily. It is also feared that the geothermal power plant sites may run out of steam in the long run.

**Prospects of Geothermal Energy in India**

India has huge potential to become a leading contributor in generating eco-friendly and cost effective geothermal power. Around 6.5 per cent of electricity generation in the world would be done with the help of geothermal energy and India would have to play a bigger role in the coming years in this direction. But, the power generation through geothermal resources is still in nascent stages in India. Geological Survey of India has identified about 340 geothermal hot springs in the country. Most of them are in the low surface temperature range from 37°C-90°C which is suitable for direct heat applications. These springs are grouped into seven geothermal provinces i.e. Himalayan (Puga, Chhumathang), Sahara Valley, Cambay Basin, Son-Narmada-Tapi (SONATA) lineament belt, West Coast, Godavari basin and Mahanadi basin. Some of the prominent geothermal resources include Puga Valley and Chhumathang in Jammu and Kashmir, Manikaran in Himachal Pradesh, Jalgaon in Maharashtra and Tapovan in Uttarakhand. A new location of geothermal power energy has also been found in Tattapani in Chhattisgarh. In addition, Gujarat is set to tap geothermal electricity through resources which are available in Cambay between Narmada and Tapi river.

Puga, which is located at a distance of about 180 km from Leh in the Ladakh region of Jammu and Kashmir across the great Himalayan range, is considered to be a good potential of geothermal energy. In Puga valley, hot spring temperatures vary from 30°C to 84°C (boiling point at Puga) and discharge up to 300 liters /minute. A total of 34 boreholes ranging in depths from 28.5 m to 384.7 m have been drilled in Puga valley. Thermal manifestations comes in the form of hot springs, hot pools, sulphur condensates, borax evaporates with an aerial extent of 4 km. The hottest thermal spring shows a temperature of 84°C and the maximum discharge from a single spring is 5 liters /second.

Chhumathang spring is another geothermal area located about 40 km north of Puga. The thermal water from Chhumathang is quite similar to the thermal waters at Puga except the difference that its water has relatively higher pH and sulphate. Geothermal activity at Manikaran occurs in the form of hot springs over a distance of about 1.25 km on the right bank of Parvati river with a temperature range of 34°C-96°C whereas on the left bank over a distance of about 450 m with a temperature range of 28°C-37°C. At Tapovan geothermal area, the highest temperature recorded is 65°C. The discharge
from this spring varies between 0.83-9.2 litre/second. Similarly, Tattapani is a promising geothermal resource in Peninsular India. Thermal manifestation at Tattapani is very intense in an area of 0.05 sq. km with several hot spots, hot water pools and marshy land. The surface manifestations show occurrence of white to dirty white deposits identified as silica and moderate to low sag activity. Sixty thermal water springs occur at eighteen localities in the West Coast hot spring belt. One geothermal power project has a capacity of 25MW. Himurja, Himachal Pradesh has decided to select some geothermal resources in Beas valley, Parvati valley, Satluj valley and Spiti valley in Himachal Pradesh for deep drilling up to 2 km for exploitation of geothermal energy.

Obviously, geothermal energy has great potential as a clean, green and naturally occurring renewable source of energy. Geothermal hot water can be used for many applications that require heat including heating buildings, raising plants in greenhouses, drying crops, heating water at fish farms, and several industrial processes. It can be used for generating electricity as well. It is therefore necessary to explore the possibility of setting up more geothermal power plants to use the naturally occurring renewable source of energy.

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