International Journal of Pollution and Noise Control
Vol. 1: Issue 2
www.journalspub.com

Geothermal Energy and Its Future as Renewable Energy

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ABSTRACT

This paper discusses the use of geothermal energy in our energy system. The paper stresses with different ways in which geothermal energy can be converted into electrical energy. The paper also shows the different geothermal projects in the world and some potenial regions where Geothermal energy can be extracted in India. The paper then discusses some alternative uses of geothermal energy. The paper at last suggests some technological changes which can be applied in future to make this potential energy much more useful.

Keywords: compressed CO_2, electricity, graphene, geothermal energy

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INTRODUCTION

The term Geothermal originates from two Geek words 'GEO' and 'THERM'. The Greek word ‘geo’ means the earth whilst their word for ‘therm’ means heat from the earth.All the renewable energies are provided by natural resources such as sunlight, wind, water, and geothermal heat. Through the use of advanced engineering technologies, we are able to collect the energy and to convert it in a more usable form. Geothermal energy is extracted from the heat stored in earth. The earth’s centre is a distance of approximately 4000 miles and is so hot that it is molten. Temperatures are understood to be at least 5000 degrees centigrade.[1] This heat from the center of earth conducts outwards and heat up the rocks. Rain water sometimes seeps down through geological fault lines and cracks becoming super heated by the hot rocks below. Some of this super heated water rises back to the surface of the earth where it emerges as hot springs or even geysers. Sometimes the hot water becomes trapped below the surface as a geothermal reservoir. Pumps are used to extract the heat and use it for different purposes.

BACKGROUND OF GEOTHERMAL ENERGY

Geothermal energy is well established energy sector. Earlier In 2008 Geothermal power production exceeded three times that of solar power. Current growth in geothermal sector is steady, but rather slow. While wind and solar photovoltaic energy are undergoing acclerating growth in its development, geothermal energy has rather sen a linear growth. So far its deployment has relied mainly on hot rocks and water located on special geothermal places.[2–5]

USE OF GEOTHERMAL ENERGY

There are two main categories of utilization of geothermal energy and they are power generation and direct use.

Direct use of geothermal energy means that the thermal energy from underground is used directly as heat, rather than being used to generate electricity. There are significant advantages of geothermal energy over other energy sources. Geothermal energy is available around the clock, independent of the time of day and night, or of the current climatic conditions.

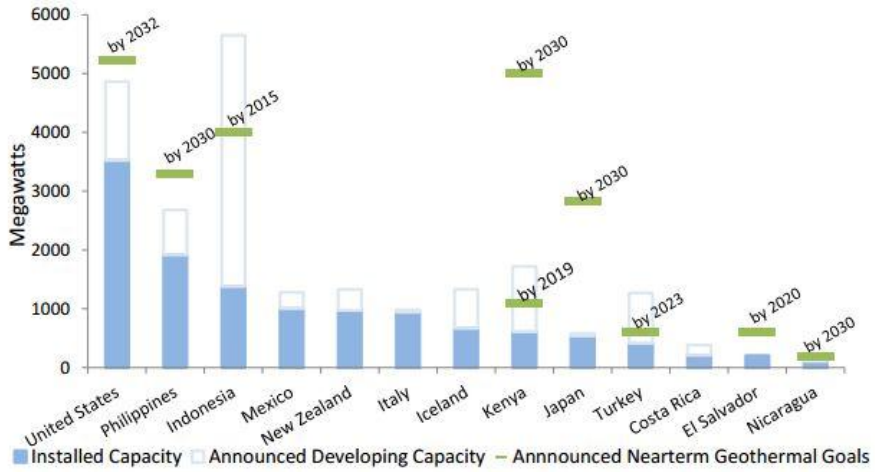
When used to generate electricity, this means that geothermal energy is suited to producing energy at a constant level, in contrast to the variable output of wind and solar power, and the peaking output of hydropower and some bio-power. Geothermal energy's potential is humongous, environmentally friendly and is only marginally developed.

GEOTHERMAL POWER IN EARTH

The centre of the Earth is around 6000 degrees Celsius - easily hot enough to melt rock. Even a few kilometres down, the temperature can be over 250 degrees Celsius if the Earth's crust is thin. In general, the temperature rises one degree Celsius for every 30 - 50 meters you go below. This value does vary depending on location in volcanic areas where molten rock can be very close to the surface. Geothermal energy has been used for thousands of years in some countries for cooking and heating.

The geothermal potential of high-temperature resources suitable for electricity generation with conventional technologies such as steam turbines, binary turbines is spread rather irregularly and depends on the volcanic zones. Geothermal power plants are in operation in about 80 countries. As of 2015, worldwide geothermal power capacity amounts to 12.8 (GW). The main producers of geothermal energy are United States(3.5 GW), Philippines (1.9 GW), Indonesia (1.2 GW) and Mexico (1 GW).

Figure 2: Important Geothermal Markets Announced Planned Capacity Additions & Targets



Note: "Nearterm Goals" includes government and private sector development goals. Mexico has set a general renewable energy goal of 35% of generation from renewables by 2024; however, this goal is not geothermal specific. The U.S. goal is Imperial Irrigational District's objective of building out geothermal capacity at the Salton Sea Resource Area by 2032.

- Based on current data the global geothermal industry is expected to reach between 14.5 GW and 17.6 GW by 2020.
- Overall if all countries follow through on their geothermal power development goals and targets the global market could reach 27-30 GW by the early 2030s.
- This is the third year in a row the global geothermal industry has sustained a growth rate of 5%.
- The World Bank estimates as many as 40 countries could meet a large proportion of their electricity demand through geothermal power.
- Since 2005, over 160 geothermal power projects have been built adding an additional 4 GW to electricity grids across the globe.
- The United Nations this year formed a Global Geothermal Alliance. This alliance was signed by 23 countries. The alliance is a partnership platform

among governments for working to reduce the investment risks associated with exploratory drilling, along with the associated costs, which have constituted a main obstacle to geothermal power expansion and offers.

Figure 1: International Geothermal Power Nameplate Capacity (MW)

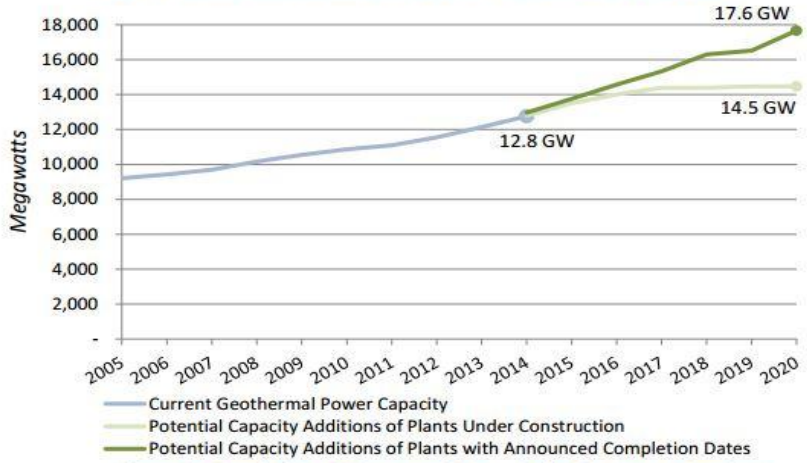
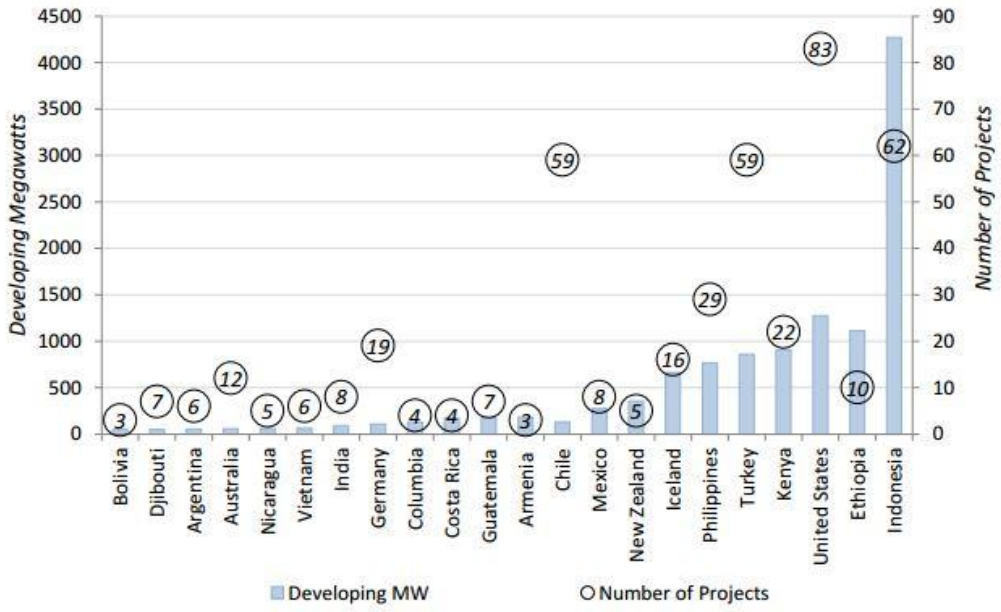


Figure 5: Developing Projects and Capacity by Country or Territory



GEOTHERMAL ENERGY IN INDIA

The major sources of commercial energy in India are coal and oil. The natural resources for commercial energy are limited in the country. It needs no emphasis that rural energy is an important component of rural development programme and needs proper consideration in the renewable energy sector policy of the country. There is no doubt that we should first be clear about the availability of various resources for practical utilization to the feasible extent within our own limited financial ability.

India's geothermal energy installation capacity is experimental. Commercial uses are insignificant. India has potential resources to harvest geothermal energy. The resource map for India has been grouped into six geothermal provinces.[6,7]

- Himalayan Province – Tertiary Orogenic belt with Tertiary magmatism
- Areas of Faulted blocks – Aravalli belt, Naga-Lushi, West coast regions and Son-Narmada lineament
- Volcanic arc – Andaman and Nicobar arc
- Deep sedimentary basin of Tertiary age such as Cambay basin in Gujarat
- Radioactive Province – Surajkund, Hazaribagh, Jharkhand
- Cratonic province – Peninsular India

India has about 340 hot springs spread over the country. Of this, 60 are distributed along the northwest Himalaya, in the States of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. They

are found concentrated along a 30-50-km wide thermal band mostly along the river valleys.

India has reasonably good potential for geothermal; the potential geothermal provinces can produce 10,600 MW of power (but experts are confident only to the extent of 100 MW). But yet geothermal power projects has not been exploited at all, owing to a variety of reasons, the chief being the availability of plentiful coal at cheap costs. However, with increasing environmental problems with coal based projects, India will need to start depending on clean and eco-friendly energy sources in future; one of which could be geothermal.

With India's geothermal power potential of 10,600 MW, the following are the potential sources/ regions where geothermal energy can be harnessed in India.

Province	**Surface temp (°C)**	**Reservoir temp (°C)**	**Heat flow**	**Thermal gradient**
Himalaya	>90	260	468	100
Cambay (Gujrat)	40-90	150-175	80-93	70
West Coast	46-72	102-137	75-129	47-59
Sonata (Son-Narmada-Tapi)	60-95	105-217	120-290	60-90
Godavari	50-60	175-215	93-104	60

List of Geothermal Energy Companies in India:

- Panx Geothermal
- LNJ Bhilwara
- Tata Power
- Thermax
- NTPC
- Avin Energy Systems
- GeoSyndicate Power Private Limited

FUTURE TECHNOLOGICAL CHANGES IN GEOTHERMAL ENERGY

Engineered Geothermal Systems

Naturally hot groundwater is not the only source of geothermal energy. In the last few years, technology is being developed that creates energy by injecting water into "dry" – ow-permeability – rocks, such as fractured granite. Terms used to refer to this include enhanced geothermal systems, hot fractured rock and hot dry rock.

The rocks chosen for this purpose are found deep underground in high-temperature environments with a strong geothermal gradient. Two wells are drilled about 100 meters apart. Water is injected at high pressure into one of the wells, expanding or creating a network of fractures in the rock. The water is extracted via the second well after it has been heated by its passage through the hot rock formation. Once the water is able to circulate through the network of fractures, a constant stream of cold water is injected into the rock and hot water is recovered.

Using End-of-Life Oil Fields

Geothermal energy could also mean a new lease of life for depleted oil fields. It could

use the water associated with oil reservoirs in sedimentary basins, which can be very hot. The oil fields are closer to the hotter rocks. So why not "create" hot water beneath the surface by injecting cold water into dry, hot rock formations and then recovering the water once it has been heated through contact with them.

Using Graphene-Based Materials

Graphene is an allotrope of carbon in the form of a two-dimensional, atomic-scale, hexagonal lattice in which one atom forms each vertex. It is the basic structural element of other allotropes, including graphite, charcoal, carbon nanotubes and fullerenes. Essentially this form of carbon provides great thermal conductivity. Now if we could use nano coated drill bits to dirll through the earth crust to the mantle and put a long thick cord of graphene in it, till it reaches the mantle. We then can extract all the energy we need directly from the earth to the surface. The loss of energy is minimum because of the property of graphene chain for not letting the heat escape from it. There is no green house gases emitted, no CO_2 released and can possibly be installed anywhere in earth.

CO_2 Plume Geothermal Power

Currently the CO_2 is captured at the source from fossil fuel burning electrical generation facilities. For efficient storage, the CO_2 is compressed into a liquid, which can be pumped deep into the earth, to be trapped in the same porous rock beds which once provided oily reservoirs.

But instead of just storing the CO2 underground, we can use it as a better replacement of water for extracting the geothermal energy from earth. CO_2 flows through the porous rock bed deep in the earth more quickly than water, collecting as much heat more easily. More importantly, the CO_2 expands more than water when heated, so the pressure differential between the CO_2 pumped into the ground and the heated CO_2 is much greater than the pressure differential of the water making the same loop. *The amount of energy that can be generated depends on this pressure differential -- and is therefore substantially greater in CPG than in traditional geothermal plants.*

CONCLUSION

Renewable energy technologies offer the promise of clean, abundant energy gathered from selfrenewing resources such as the sun, wind and earth. Each of the renewable energy technologies is in a different stage of research, development and all have differences in current and future expected costs, current industrial base and resource availability.

At present, the scale of geothermal power industry is small because of the limitation of easily exploitable high temperature geothermal resources. Therefore, the development of geothermal resources have to be primarily focused on utilization of ground source heat pumps which can make good use of the enormous low temperature geothermal resources.

There is significant scope for developing geothermal energy resources in India and other renewable energy has the potential to provide sufficient electricity to meet all of India's domestic electricity requirements.

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