Geothermal Energy and Possibility Use It in Iraq

Hassan Jassim
Electrical Department, College of Engineering,
Babylon University, Iraq

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Abstract:-

Geothermal energy is promised source of renewable and sustainable energy for production of electricity and offer a wide variety of choices in terms of direct heat applications such as heating and cooling homes, warming swimming pools, and agriculture applications. Two approach are used in production of geothermal energy, the first one is called power plants, and second one is called heat pump. The power plants approach based on three different techniques are dry steam power plants, flash steam power plants, and binary cycle power plants. Heat pump used for cooling homes in summer and heat it in winter. Moreover, this paper summarized, historical background of development geothermal energy, main technologies used in this field, installed geothermal electric capacity for two period are 2007 and 2010 for 24 countries. Finally, results made during the 'reporting period'. In an effort to keep the search clearly arranged and within the given space constrains, some details are left out.

Keywords: Geothermal energy, development of geothermal energy, production of geothermal energy, techniques of power plant.

1. Introduction

The rapidly growing influence of human activity on the environment has changed the way human beings view the world and their relationship with it. Until the middle of the twentieth century, the world was seen as an essentially stable, unchanging landscape. What changes occurred were either of small global impact or constrained to play out on time scales more familiar to geologists than the average worker, politician, or student. However, over the last 50 years the cumulative effects of industrial activity, coupled in complex ways with population growth and economic development, have become more apparent. We are now capable of monitoring every aspect of the planet's environment and have come to realize that the world and the biology it supports have long been evolving in response to our actions. Underlying every aspect of the human juggernaut has been the ability to access and utilize what seemed to be boundless and benign fossil energy resources. With the realization that those energy resources are, in fact, exhaustible and that their use is affecting the global hydrosphere, biosphere, and atmosphere, there has developed an interest in finding and developing energy resources that have minimal environmental impact and are sustainable. Geothermal energy is one such resource. Geothermal energy is ubiquitous, abundant, and inexhaustible. It powers the movement of the continents across the face of the planet, it melts rock that erupts as volcanoes, and it supplies the

energy that supports life in the ocean depths. It has been present for 4,500 million years and will be present for billions of years into the future. It flows through the earth constantly, 7 days a week, rain or shine, eon upon eon. It has the potential to provide power to every nation in the world in the United States alone, it has been noted that the amount of geothermal energy available for power generation exceeds by several times the total electrical power consumption of the country. All of this is possible and with minimal environmental consequence [5]. Geothermal energy, the heat of the Earth, provides continuous, 24-hour a day, clean, sustainable energy production. Together, advances in technology, private investment, and government support are increasing geothermal energy production in the U.S. and worldwide [Geo101,25]. Geothermal power plants tap certain high-temperature resources (above 190°F) to generate electricity with minimal or no air emissions. Heat pumps and 'direct-use' applications, which rely on more common low-temperature resources (typically from as low as 70°F up to 300°F) are used throughout the country as an energy and dollar saving alternative to traditional furnaces and boilers. Two challenges for geothermal energy are that resources are difficult to locate and tend to be found in rural areas. The fact that they are found in remote areas constrains generation and direct use development. It is difficult to transmit heat energy or electricity to the population centers where people will use it [26].

At the core of the Earth, thermal energy is created by radioactive decay [1] and temperatures may reach over 5000 degrees Celsius (9,000 degrees Fahrenheit). Heat conducts from the core to surrounding cooler rock. The high temperature and pressure cause some rock to melt, creating magma convection upward since it is lighter than the solid rock. The magma heats rock and water in the crust, sometimes up to 370 degrees Celsius (700 degrees Fahrenheit) [3] From hot springs, geothermal energy has been used for bathing since Paleolithic times and for space heating since ancient Roman times, but it is now better known for electricity generation. Worldwide, about 10,715 megawatts (MW) of geothermal power is online in 24 countries. An additional 28 gigawatts of direct geothermal heating capacity is installed for district heating, space heating, spas, industrial processes, desalination and agricultural applications. [4] Geothermal power is cost effective, reliable, sustainable, and environmentally friendly [5] but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels. As a result, geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels.

2. Theoretical Background

Geothermal comes from the Greek word Geo which means earth and thermal which means heat. So, Geothermal means energy or power extracted from beneath the earth. The energy inside the earth was formed by the decay of minerals and forests several years ago. Traditionally, it was used for bathing and heating purposes but today it is also used for generating electricity. Geothermal energy is called renewable source of energy because heat is continuously produced inside the earth [27].

This heat is brought to the near-surface by thermal conduction and by intrusion into the earth's crust of molten magma originating from great depth. As groundwater is heated, geothermal energy is produced in the form of hot water and steam. Geothermal energy is produced inside the earth's surface. The earth's layer consists of innermost layer called Iron Core which itself has two layers: solid iron core and an outer core made of hard rock, called magma, mantle which surrounds the core and the outermost layer called crust which forms oceans and continents [27].

2.1. Geothermal Energy Existence

Geothermal energy exists in the form of:

i- Volcanoes

ii- Hot Springs

iii- Geysers

Geothermal energy is clean and sustainable and environment friendly. It may be noted that the so called 'ring of fire' of the Earth envelopes the Pacific rim. Though there are over 300 hot springs sites in India, this form of energy is yet to be tapped. In

USA, California generates highest amount of electricity through Geothermal energy.

When magma comes close to the earth's surface i.e. crust it heats up the ground water which gets trapped in porous rocks. They may also flow along faults and fractured rock surfaces. Now these hydrothermal resources have 2 ingredients: water (Hydro) and heat (thermal). When these hydrothermal resources occur naturally these are called Geothermal reservoirs. Various tools and techniques are used nowadays to detect geothermal reservoirs.

2.2. Historical Review

Early 1900's First geothermal electricity commercialization Conversion of high-grade hydrothermal resources to electricity began in Italy in the early 1900s.

1960 U.S. commercialization The first commercial-scale development tools were placed at The Geysers in California, a 10-megawatt unit owned by Pacific Gas & Electric.

1970 Reinjection of geothermal fluids Injection of spent geothermal fluids back into the production zone began as a means to dispose of waste water and maintain reservoir life.

1972 Deep well drilling Technology improvements led to deeper reservoir drilling and access to more resources.

1977 Hot dry rock demonstrated In 1977, scientists developed the first hot dry rock reservoir at Fenton Hill, New Mexico.

1978 Federal research and development (R&D) funding exceeds $100 million U.S. Department of Energy (DOE) funding for geothermal research and development was $106.2 million (1995 dollars) in fiscal year 1978, marking the first time the funding level surpassed $100 million. It remained above $100 million until fiscal year 1982, when it was reduced to $56.4 million (1995 dollars). Currently, the budget is in the $30 million to $40 million range. 1978 Public Utility Regulatory Policies Act

(PURPA) enacted PURPA mandated the purchase of electricity from qualifying facilities (QFs) meeting certain technical standards regarding energy source and efficiency. PURPA also exempted QFs from both State and Federal regulation under the Federal Power Act and the Public Utility Holding Company Act.

1980 First commercial binary system The first commercial-scale binary plant in the United States, installed in Southern California's Imperial Valley, began operation in 1980.

1980's California Standard Offer Contracts California's Standard Offer Contract system for PURPA QFs provided renewable electric energy systems a relatively firm and stable market for output, allowing the financing of such capital-intensive technologies as geothermal energy facilities.

1982 Hydrothermal generating capacity of 1,000 megawatts Geothermal (hydrothermal) electric generating capacity, primarily utility-owned, reached a new high level of 1,000 megawatts.

1989 Geopressured power plant demonstrated In 1989, DOE and the Electric Power Research Institute operated a 1-megawatt demonstration plant in Texas, extracting methane and heat from brine liquids.

1990 Drop in Federal funding for geothermal R&D to $15 million DOE funding for geothermal energy research and development declined throughout the 1980s, reaching its low point in fiscal year 1990.

1991 Magma drilling project reaches a depth of 7,588 feet The world's first magma exploratory well was drilled in the Sierra Nevada Mountains to a depth of 7,588 feet. It did not encounter magma at that depth inside the caldera.

1994 Industry consolidates and looks at new markets California Energy became the world's largest geothermal company through its acquisition of Magma Power. Near-term international markets gained the interest of U.S. geothermal developers.

1985-95 U.S. geothermal developers have added nearly 1,000 megawatts of geothermal electric generating capacity outside The Geysers

1995 Worldwide geothermal capacity of 6,000 megawatts in 20 countries [28].

In 2006, a binary cycle plant in Chena Hot Springs, Alaska, came on-line, producing electricity from a record low fluid temperature of 57 °C (135 °F) [20].

The International Geothermal Association (IGA) has reported that 10,715 megawatts (MW) of geothermal power in 24 countries is online, which is expected to generate 67,246 GWh of electricity in 2010 [21] This represents a 20% increase in online capacity since 2005. IGA projects growth to 18,500 MW by 2015, due to the projects presently under consideration, often in areas previously assumed to have little exploitable resource [21]

In 2010, the United States led the world in geothermal electricity production with 3,086 MW of installed capacity from 77 power plants [22] The largest group of geothermal power plants in the world is located at The Geysers, a geothermal field in California [23]. The Philippines is the second highest producer, with 1,904 MW of capacity online. Geothermal power makes up approximately 27% of Philippine electricity generation [22].

3. Geothermal Electricity production

A: power plants technology

Most power plants need steam to generate electricity. The steam rotates a turbine that activates a generator, which produces electricity. Many power plants still use fossil fuels to boil water for steam. Geothermal power plants, however, use steam produced from reservoirs of hot water found a couple of miles or more below the Earth's surface. There are three types of geothermal power plants: *dry steam, flash steam,* and *binary cycle*. [29].

i-Dry steam power plants draw from underground resources of steam (>455 °F, or >235 °C). The steam is piped directly from underground wells to the power plant, where it is directed into a turbine/generator unit. There are only two known underground resources of steam in the United States: The Geysers in northern California and Yellowstone National Park in Wyoming, where there's a well-known geyser called Old Faithful. Since Yellowstone is protected from development, the only dry steam plants in the country are at the Geysers. [30].

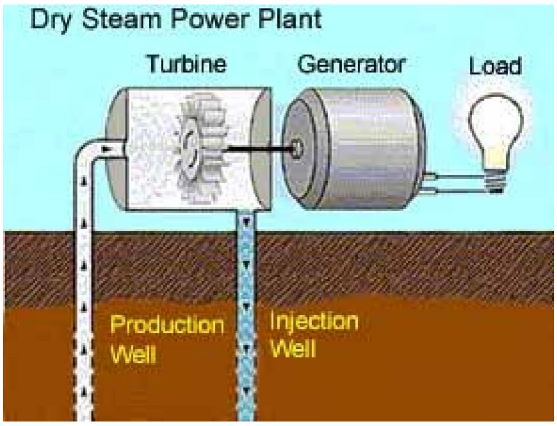

Figure 1: Block Diagram of Dry Steam Plant of Geothermal production

ii-Flash steam power plants are the most common. They use geothermal reservoirs of water with temperatures greater than 360°F (182°C). This very hot water flows up through wells in the ground under its own pressure. As it flows upward, the pressure decreases and some of the hot water boils into steam. The steam is then separated from the water and used to power a turbine/generator. Any leftover water and condensed steam are injected back into the reservoir, making this a sustainable resource.

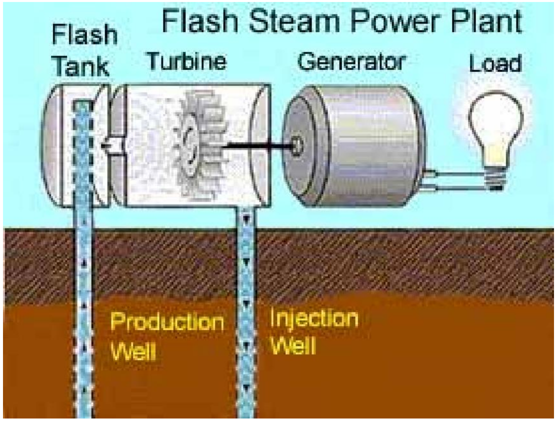

Figure 2: Block Diagram of Flash Steam Power Plant of Geothermal production

iii-Binary cycle power plants operate on water at lower temperatures of about 225°-360°F (107°-182°C). These plants use the heat from the hot water to boil a *working fluid,* usually an organic compound with a low boiling point. The working fluid is vaporized in a *heat exchanger* and used to turn a turbine. The water is then injected back into the ground to be reheated. The water and the working fluid are kept separate ed during the whole process, so there are little or no air emissions.

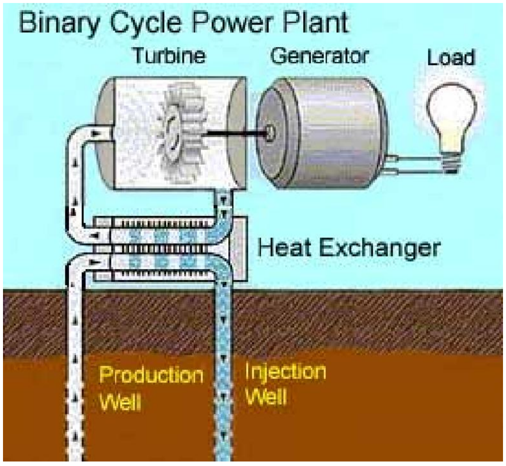

Figure 3: Block Diagram of Binary Cycle Power Plant of Geothermal production

B: Geothermal Heat Pumps

Not all geothermal energy comes from power plants. Geothermal heat pumps can do all sorts of things—from heating and cooling homes to warming swimming pools. These systems transfer heat by pumping water or a refrigerant (a special type of fluid) through pipes just below the Earth's surface, where the temperature is a constant 50 to 60°F. During the winter, the water or refrigerant absorbs warmth from the Earth, and the pump brings this heat to the building above. In the summer, some heat pumps can run in reverse and help cool buildings. Ho Almost everywhere, the shallow ground or upper 10 feet of the Earth's surface maintains a nearly constant temperature between 50° and 60°F (10° and 16°C). Geothermal heat pumps can tap into this resource to heat and cool buildings. A geothermal heat pump system consists of a heat pump, an air delivery system (ductwork), and a heat exchanger-a system of pipes buried in the shallow ground near the building. In the winter, the heat pump removes heat from the heat exchanger and pumps it into the indoor air delivery system. In the summer, the process is reversed, and the heat pump moves heat from the indoor air into the heat exchanger. The heat removed from the indoor air during the summer can also be used to provide a free source of hot water. [31].

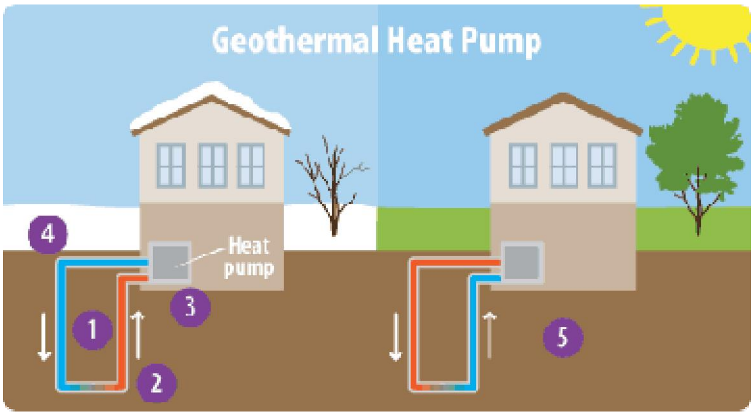

Figure 4: Schematics of Heat pumas production using for heating and cooling homes

i-Hot water is pumped from deep underground through a well under high pressure.

ii-When the water reaches the surface, the pressure is dropped, which causes the water to turn into steam.

iii-The steam spins a turbine, which is connected to a generator that produces electricity.

iv-The steam cools off in a cooling tower and condenses back to water.

v-The cooled water is pumped back into the Earth to begin the process again.

4. Disadvantages of Geothermal Energy

1) Only few sites have the potential of Geothermal Energy.

2) Most of the sites, where geothermal energy is produced, are far from markets or cities, where it needs to be consumed.

3) Total generation potential of this source is too small.

4) There is always a danger of eruption of volcano.

5) Installation cost of steam power plant is very high.

6) There is no guarantee that the amount of energy which is produced will justify the capital expenditure and operations costs.

7) It may release some harmful, poisonous gases that can escape through the holes drilled during construction.[32]

5. Future Of Geothermal Energy

The future of geothermal energy depends on three factors: it’s demand, supply and it’s competitiveness among other renewable resources in terms of cost, availability, reliability etc.. Demand for geothermal energy is going to increase and increase with the increase in the population and extinction of other non-renewable sources. Moreover, today government also support the resources which are cleaner and do not spoil the environment. Supply of geothermal energy is limited and confined to certain areas only. The entire resource of geothermal energy is fairly bigger than that of coal, oil and gas. Geothermal energy can be made more widely available if the methods and technologies used to extract it are improved. Geothermal energy is still not explored fully. Several miles below the earth surface is hot, dry rock being heated by the molten magma directly below it.

6. Results and Discussion

Figure 5 shows the growth of geothermal production since 1995 up to 2010, we note that a considerable improvements in production of electricity reach to 67GW in 2010. This improvement of geothermal production due to improved technology of production, support of Governments of countries that interested in this field. Table .1, contain the installed geothermal electric capacity for 25 countries. These countries included US of America and other European and Asian countries. We note, that the electric capacity increased in 2010 compared with 2007 due to same reasons mention above. US of America is consider the first country in Geothermal production and Thailand represent last country as we note n Table 1. Figure 6, illustrated the heat flow Map of earth for 6km depth temperatures, we note that the increasing in depth of earth causing the increasing in temperatures. In this range of temperatures degrees the geothermal production can be used for different types of production. Figure 7, shows the levelized costs of selected technologies, we note that cost of geothermal energy is so much lesser than the cost of solar energy for same power production.

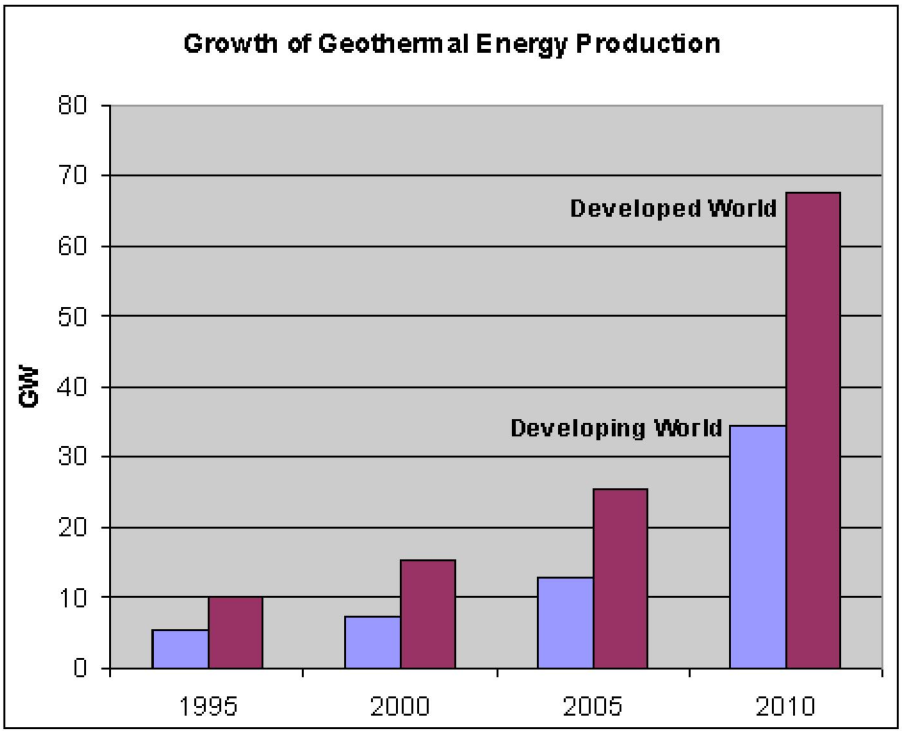

Figure 5: Growth of Geothermal Energy Production[31]

Table 1. Installed geothermal electric capacity

Country	Capacity (MW) [12] 2007	Capacity (MW)[24] 2010	Percentage of national production
United States	2687	3086	0.3%
Philippines	1969.7	1904	27%
Indonesia	992	1197	3.7%
Mexico	953	958	3%
Italy	810.5	843	1.5%
New Zealand	471.6	628	10%
Iceland	421.2	575	30%
Japan	535.2	536	0.1%
Iran	250	250	

El Salvador	204.2	204	25%
Kenya	128.8	167	11.2%
Costa Rica	162.5	166	14%
Nicaragua	87.4	88	10%
Russia	79	82	
Turkey	38	82	
Papua-New Guinea	56	56	
Guatemala	53	52	
Portugal	23	29	
China	27.8	24	
France	14.7	16	
Ethiopia	7.3	7.3	
Germany	8.4	6.6	
Austria	1.1	1.4	
Australia	0.2	1.1	
Thailand	0.3	0.3	

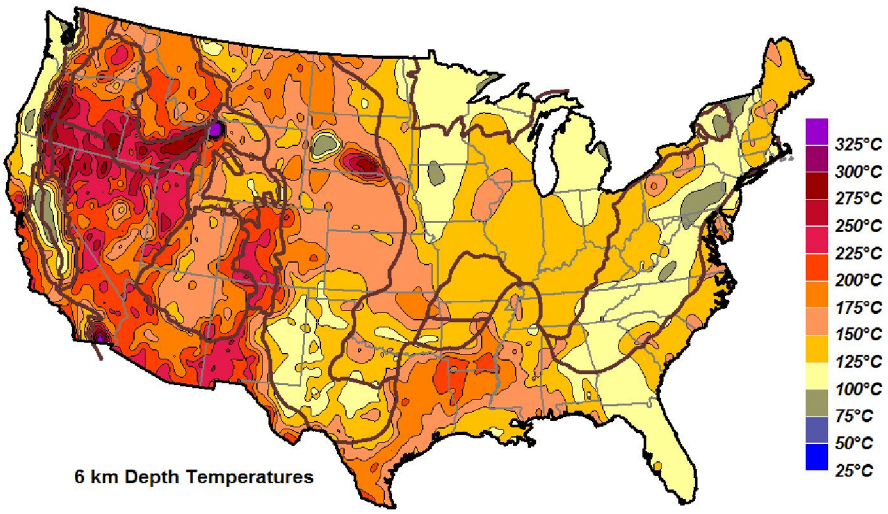

Figure 6: United States Heat Flow Map of 6km Depth Temperatures[25]

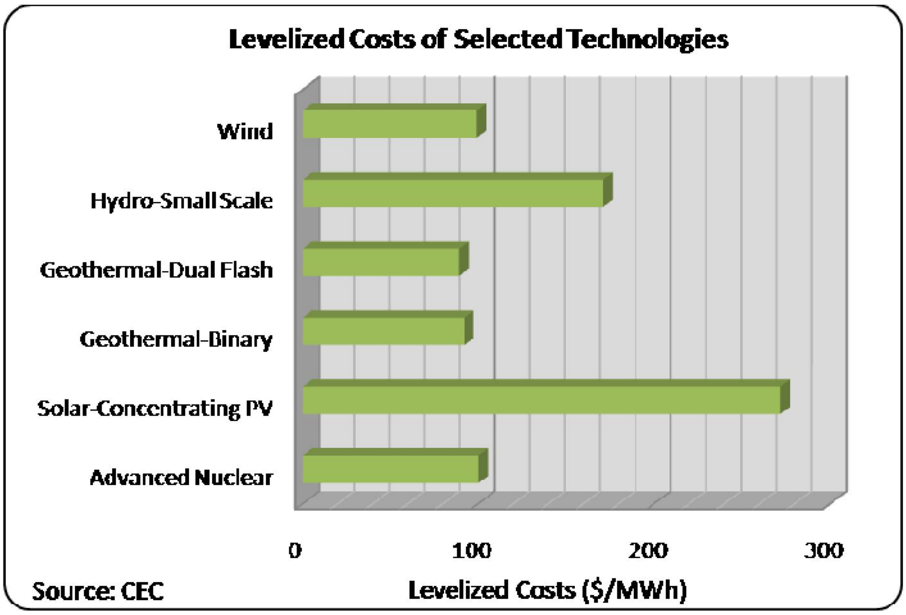

Figure 8: Levelized costs of selected technologies

7. Conclusions

We conclude that, the Geothermal energy is promised energy in production of electricity and other applications due to environment friendly, sustainability and effective cost (need initial cost only). Geothermal energy used in other fields such as heat and cooling homes using heat pump technology. Moreover, warming swimming pools, and agriculture applications can be use geothermal energy too. The cost of power produced by geothermal energy is less cost technology compared with other renewable technologies. There are many countries used geothermal energy in production of electricity and otter applications mention above. These countries from America, European, and Asia. However, the production of electricity reach to 67GW in 2010 and it is continuous in increasing due to support the governments of these countries in this technology. The main disadvantages of geothermal energy are difficult located areas to produce geothermal energy and toxic gases can be released from the certain depth of earth through build the power plants of production..

Table 2, summarize the depth of earth in (meter) with temperatures in (F^o) and Geothermal energy utilized in this range and applications.

The important point in this search is that the possibility use this technology in our country (Iraq). Because there are many areas in north ,mid and south of Iraq represent a hot spring baths of geothermal energy such as hot spring bath in Mosul, Arpil, and Sulimanyia and other areas. This areas can be used in production of electricity or used in other applications of geothermal. energy . These areas suitable for production of electricity, because the temperatures is near crust of earth this make geothermal energy production is easier, cheaper and possible compared with produce same power in other areas.

Table 2. Summarize Temperatures degree in the Earth with different Depth

Depth of Earth (meter)	Temperatures (Fahrenheit)	Technology utilized	Applications
2-3	50o	Heating pump	Heating and cooling home and agriculture applications
1500-3000	360o	Power plant (Binary cycle power plant and (flash steam power plant)	Electricity
3000-6000	460o	Dry steam power plant	Electricity
4000000	7200o		
6400000	9000o		

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