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Technical and Economic Research in the Development of Geothermal Power Plant

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Abstract: Geothermal technology as being modular flexibility and gives us the benefits we can allow the system to load any amount we want (even for very small quantities) with relatively low investment costs, which do rise. Time to install the power plant is relatively short (between one to two years) while the time of research, exploration and development of energy resources is very long. In developing countries, due to factors such as increasing population and labor productivity (GDP per worker), time had a relatively high flexibility and there was a relatively low price flexibility; with the expected primary energy consumption of the relatively higher growth rate occurring. Most developing countries have their own energy resources, especially geothermal energy ones. A large part of new energy demand in developed countries towards clean and renewable energy sources have been diverted over the energy and maintaining its influence in these countries and on the environmental pollution in the world. Geothermal energy sources have a huge significance. The extremely high amount of thermal energy in one year can increase in requirements several times more than the projected world primary energy for 2020 (1.35×10^{4}).

Key words: Energy · Geothermal · Electricity · Cost · Technology

INTRODUCTION

Estimated Cost of Producing Electricity from Geothermal Energy: This fee includes the cost of buying the turbine, generator, condenser, cooling tower, pumps, separator and more. For a geothermal power plant with instantaneous evaporation cycle and high capacity, 100 MW of this cost about 500 dollars per kilowatt capacity power plant to be considered [1-2]. Price of power conversion units with high capacity units cost far less when capacity is less. For a 100 Megawatt power plant, it is equal to the cost (U.S. $ 106×50 = $_{E}\Phi$).

Exploration Costs $_{S}\Phi$: Access to the geothermal reservoir and its estimated capacity is very difficult and costly, especially if the desired area of the primary source is not manifested and the presence of energy such as geothermal hot springs of the geothermal fluid surface is not overtly visible. Geothermal energy exploration and operations, including studies of geology, geo-chemistry, geo-physical survey and drilling of wells testing temperature, which includes the cost of land plants and wells, respectively, among these costs, which are considered. Impact of these costs is highly significant, because these expenses occur long before any operation can be performed. With regard to exploration costs in a developed area and with 10% inflation between 1980 and 1995, the calculations in this paper for 100 MW power plants are carried out and exploration costs of about $ 10 million are to be considered. U.S. $ = 10×106.

Cost of Drilling Operations $_{w}$: The estimated cost of production and injection wells drilling operation where many factors must be considered. Drilling costs are generally a function of the number of wells, deep wells, rock type, spacing of wells (drilling machine relocation costs), ways to access the drilling site and others. Parameters in determining the cost of drilling the well are numerous. Cost of testing wells, drilling mud, cement and piping as part of drilling costs are, considered. Number of production wells needed to supply steam power, plant efficiency, depending on the wells, is variable. Amount of steam required per MW of the seven tons per hour and the average steam production rate of 30 tons per well per hour, the number of production wells = 23 wells. If the average depth of these wells in 1700 meters and the

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number of injection wells and seven rings of approximately 100 m depth to consider be considered, collectively, about 46,000 m drilling are necessary. Considering the cost rate of $ 1000 per meter, drilling costs are equal to U.S. $106 dollars [1-4].

Geothermal Fluid Transfer Fee $_F$: Cost of tapping geothermal fluid transfer between the wells and parts manufacturing plant and related pumping system is a function of the distance between production wells and power transfer units, diameter of pipes in connection with the fluid pressure and Dubai is determined, the percentage combination of insulation and geothermal fluid (corrosion and sediments in the pipes). With regard to the pipeline 15 km long and U.S. $162 dollars per meter, the cost to transfer a 100 MW power plant is: U.S. $106 * 10 = $_F$. Total cost of initial investment for an instantaneous evaporation cycle power plant with capacity of 100 MW replace values $_E$ And $_W$ and $_F$. In relation to (a) and consider the capacity is USD 106×4.221 = Alternatively, in other words, the cost for a geothermal power plant capacity of 100 MW.

The initial investment cost is 24% of operations and is related to exploration drilling and geothermal fluid transfer and 58% is related to the line and installation of the devices and power plant equipment. Electricity production cost S: Production costs using relationship (1) have been calculated.

$$S = \frac{1}{2}\left\{ i\left(\frac{S_E(i+1)n_E}{(1+i)n_E - 1} + \frac{S_E(1-1)^{n_S}}{(1+i)^{n_S} - 1} + \frac{S_W(i+1)^{n_W}}{(1+i)^{n_W} - 1} + \frac{S_f(i+1)^{n_f}}{(1+i)^{n_f} - 1} + \mathrm{OM}\right)\right\} \quad (1)$$

Where, N = S kilowatt per hour, in which the relationship is calculated; cost of buying the right land used for drilling wells is calculated from the relationship (Table 1).

$$N = 8760\ [\text{days}] \times CF\ [\%] \times P\ [\text{kW}] \quad (2)$$

Table 1: Technology Area occupied (MW hours per square meter per year for 30 years)

Area needed (m)	Plant type
3642	Coal (including coal)
3561	Solar Heating
3237	Photovoltaic
1335	Wind (occupied area and surrounding roads)
404	Geothermal

Where CF = plant capacity factor, which is variable as 70, 75, 80, 85, 90% has been considered and P = power plant and I = discount rate that varies as 6, 10, 14, 18 and 20% has been considered.

SE, Ss, SW and SF equal the total costs associated with purchasing equipment, exploration, drilling and transfer of geothermal fluid, $_E\ \Phi$, $_S\ \Phi$, $_W\ \Phi$ and $_F\ \Phi$ considering constant coefficients are calculated. NE = 20 years, NS = 50 years, NW = 10 years and NF = 20 years; time returns on investment in ordering of power plant equipment, exploration, drilling and pipelines that are listed and for longevity where, in all, equal parts are assumed. OM operation and maintenance costs that 3 percent of the total initial investment cost is considered.

Production costs increase plant capacity factor, which is decreased when increasing discount rate increases. Considering the 80 percent capacity factor and the discount rate percent, cost geothermal power plant, generating electricity capacity to 100 MW, is equal to 5 cents, of USD per kilowatt-hour compared with the cost of electricity generation costs of different energy sources. One paper estimated the cost of electricity generation in the range of geothermal energy 4.6 cents per kW h is placed and the other costs of geothermal energy to produce electricity at a much lower cost range to oil, coal and nuclear power is far below the cost of electricity generation from other unconventional means. One should compare the environmental costs considered. Geothermal power plants having the new-style gas injected into the ground are about two and therefore are not releasing any gas into the atmosphere. Estimated costs resulting from environmental pollution can be complicated and sometimes non-calculated. Side costs (environmental), costs of fossil fuels including pollution, reduce emissions of CO_2, CO, CH, NOX and SO_2, which are organic gases and thus are active. These fees impinge only on the costs that are directly affecting the environment. Military spending, for the political protection of these fuels, whilst they are associated, have not been considered. Economic comparison of geothermal energy electricity generation and other generally non-conventional energy, such as electricity generation from fossil fuels, must be considered about the cost. With this in mind, the economic costs compared to fossil geothermal power plant and more benefits will be from geothermal power plants.

Coefficient of geothermal power capacity is in the range is 70 to 90% and the base load of power plants to feed, are primarily used. Efficiency of geothermal power plants due to low pressure and temperature of steam used

in geothermal power plants is about a third of fossil-fueled steam. Because geothermal power plants belong to the local reservoir and geothermal features, large size of plant capacity from geothermal reservoir is determined, based on studies conducted on 30 to 50 megawatts of optimization capacity for geothermal fields in the world. In geothermal fields, if the water temperature is over 180°C in one or more instantaneous evaporation cycle stage and temperatures are around 85°C to 140°C cycles for double circuit system is suitable cycle technology compared to instantaneous evaporation cycle double circuit and is simpler because there is a need to heat cycle whilst the secondary fluid pump is operating. Also, the cost of buying double circuit system devices and power plant equipment is far higher than the instantaneous evaporation system. Use of geothermal energy has other benefits such as less land occupation than other types of power plants [3-6].

Technical and Economic Analysis of Geothermal Electric Energy: Use of geothermal resources, as opposed to other resources such as fossil fuel, which require heavy investment for exploration, drilling, development of geothermal fields, buying equipment and power plant equipment and accessories, should be considered. The initial investment cost of geothermal power plants Φ can be a function of the cost of buying equipment and power plant equipment and accessories Φ_E, drilling and completion costs of production and injection wells Φ_W, geothermal field exploration costs and land use $_S\ \Phi$ and plumbing costs for transferring geothermal fluid from production wells to the plant Φ_F are considered. To calculate the total cost of the investment relationship we use the following relationship:

$$\Phi_f f + \Phi_w f + \Phi_s f + \Phi_E f_(\Sigma f_i + 1) = \Phi \quad (3)$$

Where, f_i coefficients are for the direct costs of supplying the device, power plant equipment and construction plant. Φ_f, Φ_w, Φ_s and Φ_E are coefficients for indirect costs, including design engineering, legal costs etc., in order to buy plant, field exploration, geothermal drilling and transmission fluid.

Cost Estimate of Equipment and Devices Unit Transition Φ_e: This fee includes the cost of buying the turbine, generator, condenser, cooling tower, pumps, separator and more. For a geothermal power plant with instantaneous evaporation cycle and 100 MW capacity at the cost of about US $500 per kilowatt capacity power plant to be considered. Price of power conversion units with high capacity units cost far less than capacity is less. For a 100-megawatt power, plant is equal to the cost: UD $50000000 = Φ_E.

Exploration Costs Φ_S: Access to the geothermal reservoir and its estimated capacity is very difficult and costly, especially if the desired area of the primary is not the manifestation of symptoms and the presence of energy like geothermal hot springs, such as gas, volcanoes and alteration zones of geothermal fluid within the Earth's surface are not apparent. Geothermal energy exploration and operations, including studies of geology, geochemistry, geophysical surveys and drilling of wells determines the experimental temperature. The cost of the operations is listed in order of increase. Plus, the cost of buying the right land use for drilling wells and land plants among these costs are considered. Impact of these costs is very important and is significant, because these expenses are manifested long before any operation should be performed. For 100 MW power plant costs, about US $10 million in exploration is considered [4-6].

Cost of Drilling Operations $_W$: The estimated cost of production and injection wells drilling operation many factors must be considered. Drilling costs are generally a function of the number of wells, deep wells, rock type, spacing wells (drilling machine relocation cost) ways to access the drilling site and others. Parameters in determining the cost of drilling the well is deep. Cost of testing wells, drilling mud, cement and piping as part of drilling costs is considered. Number of production wells needed to supply steam power plant efficiency, depending on the wells is variable. Amount of steam required per MW of the seven tons per hour and the average steam production rate of 30 tons per well per hour, the number of production wells = 23 wells. If the average depth of these wells in 1700 meters and the number of injection wells and seven rings of approximately 100 m depth to consider S collected about 46,000 m drilling is necessary. Considering the US $1000 per meter drilling costs is equal = US $46000000.

Cost of Geothermal Fluid Transfer $_f$: Cost of tap geothermal fluid transfer between the wells and parts manufacturing plant and related pumping system is a function of the distance between production wells and power transfer units, diameter of pipes in connection with the fluid pressure and Dubai is determined, the percentage combination of insulation and geothermal fluid (corrosion

and sediment in the pipes). With regard to the pipeline of 15 km length and US $162 dollars per meter, the cost to transfer a 100 MW power plant is equal US $10 million as total cost of initial investment for an instantaneous evaporation cycle power plant with capacity of 100 MW and replacement value added, is: $\Phi_{=}$ $ 221400000. In other words, the cost for a geothermal power plant capacity of 100 MW against US $2214 dollars per kW. The initial investment cost of 24 percent of operations related to exploration drilling and geothermal fluid transfer and 58 percent related to the line and installation of the devices and power plant equipment [6-16].

CONCLUSION

Owners are motivated towards geothermal energy in order to convert this energy to electricity, considering that the current growth rate of 20 percent for geothermal energy of developed countries. Therefore, good prospects for growth of this energy are already proven. Coefficient of geothermal power capacity in the range is 70 to 90 percent and the base load power plants to feed primarily used. Efficiency of geothermal power plants due to low pressure and temperature steam geothermal power plants in about a third of fossil-fueled steam. Meanwhile, the cost of buying double circuit devices and power plant equipment systems to higher evaporation system (instantaneous). Existence of geothermal energy in developing countries, in addition to reducing dependence on fossil fuels (which is very important), makes for transference of modern technology to these countries which will also transfer much of the work relating to engineering and development resources.

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