Electrical Power Generation by Non-Conventional Energy-Geothermal

Shuchiket Darunde
BE Student
Department of Electrical Engineering
KDK College of Engineering, Nagpur, Maharashtra, India

Pratik Alone
BE Student
Department of Electrical Engineering
KDK College of Engineering, Nagpur, Maharashtra, India

Ketan Kitukle
BE Student
Department of Electrical Engineering
KDK College of Engineering, Nagpur, Maharashtra, India

Santosh Jadhav
BE Student
Department of Electrical Engineering
KDK College of Engineering, Nagpur, Maharashtra, India

Prof. Diwakar Korasane
Assistant Professor
Department of Electrical Engineering
KDK College of Engineering, Nagpur, Maharashtra, India

Abstract

Geothermal energy has the potential to provide long-term, secure base-load energy and greenhouse gas (GHG) emissions reductions. Climate change is not expected to have any major impacts on the effectiveness of geothermal energy utilization, but the widespread deployment of geothermal energy could play a meaningful role in mitigating climate change and accessible geothermal energy from the Earth’s interior supplies heat for direct use and to generate electric energy. The paper deals with the use of geothermal resources for the production of electricity next are technologies of change geothermal energy into electrical energy, future of geothermal energy and advantage and disadvantage of geothermal energy

Keywords: Geothermal, Geysers, Ground Sources, Rankin, Heat pumps

I. INTRODUCTION

Geothermal energy has the potential to provide long-term, secure base-load energy and greenhouse gas (GHG) emissions reductions. Accessible geothermal energy from the Earth’s interior supplies heat for direct use and to generate electric energy. Climate change is not expected to have any major impacts on the effectiveness of geothermal energy utilization, but the widespread deployment of geothermal energy could play a meaningful role in mitigating climate change. In electricity applications, the commercialization and use of engineered (or enhanced) geothermal systems (EGS) may play a central role in establishing the size of the contribution of geothermal energy to long-term GHG radiation.

Fig. 1: Scheme Showing Convective (Hydrothermal) Resources. Adapted From Mocket Al. (1997) and From US DOE Publications

The natural replenishment of heat from earth processes and modern reservoir management techniques enable the sustainable use of geothermal energy as a low-emission, renewable resource. With appropriate resource management, the tapped heat from an active reservoir is continuously restored by natural heat production, conduction and convection from surrounding hotter
regions, and the extracted geothermal fluids are replenished by natural recharge and by injection of the depleted (cooled) fluids. Modern power system planning approaches are notably prejudiced by renewable portfolio development and emission pricing. Conventional generation resources inherently cause emission, and intermittent renewable resources suffer from the uncertainty of supply, higher footprint and price competitiveness. Bridging the gap of conventional and intermittent generation technologies, geothermal resources can maintain secure, sustainable, reliable and economic power supply. Geothermal energy has a considerable potential to penetrate Electricity Market as an emission free, price competitive and base load electricity. Apparently the largest ‘geothermal power zone’ is located in the Cooper Basin area, which is around 1000 km away from major load centers. A long distance high capacity transmission line is required to connect this geothermal power to the existing electricity grid, the power transmission program addresses the issues of transmission planning to connect geothermal power plants to the electricity grid. Based on this research, one journal paper has been published and two other journals are under review [Hasan et al., 2012b; Hasan et al., 2012c; Radziet al., 2012]. Five national and international conference papers have also been published in this topic [Eghbalet al., 2011; Hasan et al., 2011a; b; c; 2012a]. Selected summary of those works is presented here for the Australian Geothermal Energy Conference 2012 audiences”

II. POWER PLANT

The basic types of geothermal power plants in use today are steam condensing turbines and binary cycle units. Steam condensing turbines can be used in fly ash or dry-steam plants operating at sites with intermediate- and high-temperature resources (≥150°C). The power plant generally consists of pipelines, water-steam separators, vaporizers, de-misters, heat exchangers, turbine generators, cooling systems, and a step-up transformer for transmission into the electrical grid. The power unit size usually ranges from 20 to 110 MW and may utilize a multiple flash system, flashing the fluid in a series of vessels at successively lower pressures, to maximize the extraction of energy from the geothermal fluid. The only difference between a flash plant and a dry-steam plant is that the latter does not require brine separation, resulting in a simpler and cheaper design.

Binary-cycle plants, typically organic Rankine cycle (ORC) units, are commonly installed to extract heat from low- and intermediate-temperature geothermal fluids (generally from 70 to 170°C), from hydrothermal- and EGS-type reservoirs. Binary plants (Figure 4.3, bottom) are more complex than condensing ones since the geothermal fluid (water, steam or both) passes through a heat exchanger heating another working fluid. This working fluid, such as isopentane or isobutene with a low boiling point, vaporizes, drives a turbine, and then is air cooled or condensed with water. Binary plants are often constructed as linked modular units of a few MWe in capacity. There are also combined or hybrid plants, which comprise two or more of the above basic types, such as using a binary plant as a bottoming cycle with a flash steam plant, to improve versatility, increase overall
thermal efficiency, improve load-following capability, and efficiently cover a wide resource temperature range. Cogeneration plants, or combined or cascaded heat and power plants (CHP), produce both electricity and hot water for direct use. Relatively small industries and communities of a few thousand people provide sufficient markets for CHP applications. Iceland has three geothermal cogeneration plants with a combined capacity of 580 MWth in operation (Hjartarson and Einarsson, 2010). At the Oregon Institute of Technology a CHP plant provides most of the electricity needs and all the heat demand (Lund and Boyd, 2009).

III. EXPLORATION AND DRILLING

Since geothermal resources are underground, exploration methods (including geological, geochemical and geophysical surveys) have been developed to locate and assess them. The objectives of geothermal exploration are to identify and rank prospective geothermal reservoirs prior to drilling, and to provide methods of characterizing reservoirs (including the properties of the fluids) that enable estimates of geothermal reservoir performance and lifetime. Exploration of a prospective geothermal reservoir involves estimating its location, lateral extent and depth with geophysical methods and then drilling exploration wells to test its properties, minimizing the risk. All these exploration methods can be improved. Today, geothermal wells are drilled over a range of depths down to 5 km using methods similar to those used for oil and gas. Advances in drilling technology have enabled high-temperature operation and provide directional drilling capability. Typically, wells are deviated from vertical.

IV. PROSPECTS FOR TECHNOLOGY IMPROVEMENT, INNOVATION AND INTEGRATION

Geothermal resources can be integrated into all types of electrical power supply systems, from large, interconnected continental transmission grids to onsite use in small, isolated villages or autonomous buildings. They can be utilized in a variety of sustainable power generating modes, including continuous low power rates, long-term (decades long) cycles of high power rates separated by recovery periods and long-term, uninterrupted high power rates sustained with effective fluid reinjection (Bromley et al., 2006). Since geothermal typically provides base-load electric generation, integration of new power plants into existing power systems does not present a major challenge. Indeed, in some configurations, geothermal energy can provide valuable flexibility, such as the ability to increase or decrease production or startup/shut down as required. In some cases, however, the location dependence of geothermal resources requires new transmission infrastructure investments in order to deliver geothermal electricity to load centers. For geothermal direct uses, no integration problems have been observed. For heating and cooling, geothermal (including GHP) is already widespread at the domestic, community and district scales. District heating networks usually offer flexibility with regard to the primary energy source and can therefore use low-temperature geothermal resources or cascaded geothermal heat.

V. APPLICATIONS OF GEOTHERMAL ENERGY

A. Electricity Generation:
The thermal efficiency of geothermal electric plants is low, around 10–23%, because geothermal fluids do not reach the high temperatures of steam from boilers. The laws of thermodynamics limit the efficiency of heat engines in extracting useful energy. Exhaust heat is wasted, unless it can be used directly and locally, for example in greenhouses, timber mills, and district heating. System efficiency does not materially affect operational costs as it would for plants that use fuel, but it does affect return on the capital used to build the plant. In order to produce more energy than the pumps consume, electricity generation requires relatively hot fields and specialized heat cycles. Because geothermal power does not rely on variable sources of energy, unlike, for example, wind or solar, its capacity factor can be quite large – up to 96% has been demonstrated. The global average was 73% in 2005.

B. Direct Applications:
In the geothermal industry, low temperature means temperatures of 300 °F (149 °C) or less. Low-temperature geothermal resources are typically used in direct-use applications, such as district heating, greenhouses, fisheries, mineral recovery, and industrial process heating. However, some low-temperature resources can generate electricity using binary cycle electricity generating technology. Direct heating is far more efficient than electricity generation and places less demanding temperature requirements on the heat resource. Heat may come from co-generation via a geothermal electrical plant or from smaller wells or heat exchangers buried in shallow ground. As a result, geothermal heating is economic at many more sites than geothermal electricity generation. Where natural hot springs are available, the heated water can be piped directly into radiators. If the ground is hot but dry, earth tubes or downhole heat exchangers can collect the heat. But even in areas where the ground is colder than room temperature, heat can still be extracted with a geothermal heat pump more cost-effectively and cleanly than by conventional furnaces. These devices draw on much shallower and colder resources than traditional geothermal techniques, and they frequently combine a variety of functions.
VI. ADVANTAGES OF GEOTHERMAL ENERGY

1) The cost of the land to build a geothermal power plant on, is usually less expensive than if you were planning to construct an; oil, gas, coal, or nuclear power plant. The main reason for this island space, as geothermal plants take up very little room, so you don’t need to purchase a larger area of land.

2) Another factor that comes into this is that because geothermal energy is very clean, you may receive tax cuts, and no environmental bills or quotas to comply with the countries carbon emission scheme (if they have one).

3) No fuel is used to generate the power, which in return, means the running costs for the plants are very low as there are no costs for purchasing, transporting, or cleaning up of fuels you may consider purchasing to generate the power.

4) The overall financial aspect of these plants is outstanding; you only need to provide power to the water pumps, which can be generated by the power plant itself anyway. Because they are modular, then can be transported conveniently to any site.

5) Construction time can be as little as 6 months for plants in the range 0.5 to 10 MW and as little as 2 years for clusters of plants totaling 250 MW or more.

VII. DISADVANTAGES OF GEOTHERMAL ENERGY

1) Fluids drawn from the deep earth carry a mixture of gases, notably carbon dioxide (CO2), hydrogen sulfide (H2S), methane (CH4) and ammonia (NH3). These pollutants contribute to global warming, acid rain, and noxious smells if released. Existing geothermal electric plants emit an average of 122 kilograms (269 lb) of CO2 per megawatt-hour (MW•h) of electricity, a small fraction of the emission intensity of conventional fossil fuel plants. Plants that experience high levels of acids and volatile chemicals are usually equipped with emission-control systems to reduce the exhaust.

2) In addition to dissolved gases, hot water from geothermal sources may hold in solution trace amounts of toxic chemicals such as mercury, arsenic, boron, and antimony. These chemicals precipitate as the water cools, and can cause environmental damage if released. The modern practice of injecting cooled geothermal fluids back into the Earth to stimulate production has the side benefit of reducing this environmental risk.

3) Plant construction can adversely affect land stability. Subsidence has occurred in the Wairakei field in New Zealand and in Staufen im Breisgau, Germany. Enhanced geothermal systems can trigger earthquakes as part of hydraulic fracturing. The project in Basel, Switzerland was suspended because more than 10,000 seismic events measuring up to 3.4 on the Richter Scale occurred over the first 6 days of water injection.

VIII. CONCLUSION

This research paper help us to study for of geothermal resources for the production of electricity next are technologies of change geothermal energy into electrical energy, future of geothermal energy and advantage and disadvantage of geothermal energy

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