

**2007 Interim Report
Update on World Geothermal Development
May 1, 2007**

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Reports examining the international status of geothermal development were published by the US Geothermal Energy Association (GEA) and the International Geothermal Association (IGA) in 2005. While additional detailed reports are expected to be prepared for the next World Geothermal Congress (WGC), this interim report examines the progress in international geothermal power development since 2005. It notes projects under development, major political and/or policy initiative related to development, and plans announced by either governments or in-country parties. It does not seek to update the detailed data presented in 2005. Both public and private sources were consulted for this report.

Results:

The number of countries producing geothermal power and the total worldwide geothermal power capacity under development appear to be increasing significantly in the first decade of the 21st Century. The number of countries producing power from geothermal resources could increase 120%, from 21 in 2000 to as many as 46 in 2010. Total geothermal capacity on-line could increase over 55%, from 8661 MW in 2000 to 13,500 MW or more.

While GEA reported in 2005 that new or additional geothermal power development was underway in some 15 countries, there has been considerable expansion in the number of countries considering or proceeding with new geothermal power projects. This interim report identifies 40 such countries.

Similarly, developments noted in this report would result in a dramatic expansion in the number of countries producing geothermal power. In 2000, only 21 countries were producing geothermal power. By 2005, there was a slight increase with 24 countries reporting geothermal power production. But, if all of the 22 new countries looking into geothermal energy today succeed by 2010, there could be over 46 countries producing geothermal power.

In 2000 there was 8661 MW of geothermal power capacity on-line. By 2005 there was a modest increase to 8,932 MW of installed power capacity generating 56,951 GWh per year of green power, but there was considerable new development underway. At that time the International Geothermal Association (IGA) projected that 10,700 MW would be online by 2010, and in 2005 GEA reported that this total could reach 13,500 MW by 2010 – representing a 50% growth in geothermal power since 2000. (See Figure 1 at end of report).

This interim report does not assess the specific power capacity under development in each country. In many cases the available information did not identify a specific power capacity under development. But, where capacities were given, the total of the projects under development would appear to be trending towards exceed the lower IGA estimate and approaching or surpassing the 2005 GEA estimate. This interim report suggests that 55% growth in geothermal power production between 2005 and 2010 is achievable based upon currently observed trends.

Overall, geothermal development appears to be accelerating. The trends in both the number of new countries developing geothermal energy and the total of new megawatts of power capacity under development appear to reverse slowdowns in international markets seen in the late 1990s, and approximate trends from the more robust 1980s.

Finally, it is worth noting that in numerous cases discussed in this report, the success of development in a country is linked to government policies and initiatives. The extent of future geothermal project development would appear to depend more upon adequate funding and sustained policy support than geologic factors.

Individual Country Reports:

The ARGeo Project: Massive Potential, but Funding Needed

The African Rift Valley Geothermal Development Facility (ARGeo) project is an East African organization that includes six countries – Kenya, Ethiopia, Djibouti, Uganda, Tanzania, and Eritrea – lying along the African Rift Valley, an area of massive geothermal potential (some estimates place it at 7,000 MW). ARGeo is currently petitioning the World Bank and the countries of Iceland and Germany to fund a series of projects that will bring more stable sources of power to East Africa and aid the region in developing their geothermal resources.

The World Bank, as the main financier of the ARGeo project, is expected to approve it in November. A Risk Mitigation Fund of \$17.75M USD is expected also to be approved sometime during 2007.

Kenya

Kenya currently generates 129 MW of geothermal energy from its geothermal power plant in the Olkaria region, representing 11% of the national capacity. In 2006, 13 officials from the Kenyan Electricity Generating Company (KenGen) attended the Addis ARGeo Conference, where it was conveyed that Kenya has “huge potential” for geothermal development. However, like the other countries involved in the project, Kenya lacks the venture capital necessary to identify geothermal fields and start development. Exploration drilling in Kenya costs an estimate of four to five million American dollars per exploration hole.

Ethiopia

Ethiopia's geothermal potential has been placed at 1,000 MW, but only 8.52 MW has been harnessed at any one time. Ethiopia's one geothermal plant, the Aluto-Langano plant, was decommissioned in the late 1990s after two years of operation. The government of Ethiopia has entered into a contract with Geothermal Development Associates (GDA), a US-based company, to rebuild the Aluto-Langano plant. Ethiopia has also brought in outside groups to identify geothermal fields, which they have found at Tendaho (20 MW potential), Korbetti, Dofan, Abaya, Fentale, and Tulu Moye. A recently submitted proposal to the World Bank outlines plans to develop any two of these fields.

Djibouti

Djibouti has identified several sites of geothermal potential in Lake Assal, Arta, and Obock, and is planning to use these sites for tourism development as well as geothermal energy production. The President of Djibouti, Ismail Omar Guelleh, met with the President of Iceland in February 2007 to discuss cooperation efforts in this endeavor. Also, Djibouti's power company, Electricite de Djibouti (EDD), recently entered into an agreement with the Ethiopian Electric Power Cooperation (EEPCO) to share any electricity surplus that either country may acquire.

Uganda

Uganda's main geothermal prospects lie in the hot springs of the volcanic regions of the West, where extremely high temperatures of 500°C to 1000°C have been recorded. Officials have placed geothermal potential at 450 MW, but a one million American dollar per exploration hole cost has prevented Uganda from commencing exploration. In 1994, a joint venture between the Organization of the Petroleum Exporting Countries (OPEC) and the Icelandic government found that three sites in Uganda along the African Rift Valley offer viable geothermal potential: Buranga, Katwe (in the volcanic fields), and Kibiro (in the northern Rift Valley). Realizing Uganda's geothermal potential would do much to alleviate the problems of rural electrification, which has kept Uganda from providing more than 7% of its citizens with electricity.

Tanzania

In late 2006, the Geological Survey of Tanzania toured the hot springs of Tanzania and found one promising location for geothermal development. However, Tanzania is hindered by the twin stumbling blocks of capacity and financing. Capacity cannot be estimated until financing is provided for exploration, but financing from foreign sources will be slow until a reliable estimate of capacity is achieved. This is one of the problems that the ARGeo project is working to solve.

Rwanda

Rwanda, while not a member of the ARGeo project yet, is seeking membership due to an estimate by Chevron that geothermal could be harnessed in two sites outside of Volcanoes National Park. Rwanda has contacted the GDA for a more thorough assessment. Rwanda is seeking to develop geothermal power after its fossil fuel and hydropower plants recently failed to provide almost 45% of Rwanda's energy needs due to a long dry spell.

Armenia: New Plant May Come Online Next Year

In April 2006, Armenia announced intentions to build a 25 MW plant stemming from 6 wells, planning to finish the plant sometime in 2008-09.

Australia: Developing EGS/Hot Dry Rock Systems

Australia has seen marked increases in geothermal development since the WGC2005. While currently only one 120 kilowatt (kW) plant is operational, four companies are spearheading a total of five different projects to prove the effectiveness of hot dry rock (HDR) technology – also known as Enhanced Geothermal Systems (EGS) technology: geothermal systems that are enhanced through engineering to produce more energy than they ordinarily would. The Habanero plant, named for its high temperatures, will be completed by the end of the year, and with its completion will officially become the first geothermal plant in Australia to utilize HDR technology. In addition, Australia has seen increasing license applications for geothermal fields and expenditure on geothermal energy every year since 2000, with a 57% increase in applications in the last year alone. This represents a growing confidence in HDR/EGS Systems which represent the majority of Australia's geothermal potential.

Canada: First Power Plant Underway, Wider Potential Eyed

Canada has just begun to realize its full geothermal potential. After a 2-month period of negotiations, Western Geopower Corp. sold off \$7 million worth of shares to the Dundee Corporation in order to finance a production well in the South Meager region. After drilling the well, Canada claimed in October 2005 that a 100 MW plant could be built by 2007. As of yet, Canada has relatively few projects planned, but may soon begin contracting out more development as they continue to assess their capacity for geothermal energy. There has also been public discussion about using geothermal resources to power the conversion of oil from Canada's vast tar sands deposits.

Chile: Working with Help from Abroad

Chile and Italy have recently come together to plan the drilling of several wells in the southern regions of Chile. The Empresa Nacional de Geotermia S.A., jointly owned by the Italian company Enel and the Chilean company ENAP, is currently exploring the potential of the lands on which it holds geothermal leases. Exploration is centered in the north, where numerous applications for geothermal leases have recently been filed.

China: Private Firms Developing More Geothermal Energy

Chinese partners Shaanxi Energy and Enx China began development of Xian Yang plant in December of 2006. China currently runs a number of geothermal plants in Tibet, the oldest of which dates back to the 1970's. The Chinese government remains interested in examining additional potential for geothermal power, including power from medium to lower-temperature resources outside of the traditional geothermal power areas. China's low temperature resources are known to be extensive, since China is a major user of geothermal resources for direct use purposes such as space heating and commercial fish production, and now claims to be the world leader in utilizing geothermal energy.

Dominica: See OAS Eastern Caribbean Geothermal Energy Project

Djibouti: See ARGeo Project

El Salvador: Continued Success, Growing Output

El Salvador plans to increase its overall output from 134 MW to 190 MW, stemming from two new units in the Berlin geothermal field and the optimization of the Ahuachapán field. At 190 MW, geothermal energy will represent 30% of energy needs in El Salvador. El Salvador continues to develop geothermal energy, and is looking now to new fields in the San Vicente and Chinameca areas, where drilling is set to begin this year.

Ethiopia: See ARGeo Project

Germany: Several new projects under development

Germany is still in the exploration stages of many of its projects, but has several plans for plants in various areas of geothermal activity. These areas include Unterhaching (one 3.36 MW plant), Eberswalde (one 25 MW plant), and Hagenbach (four 4.6 MW plants). The country's progress is noticeable, and they remain committed to exploring geothermal opportunities. Reportedly there are over 100 different sites being examined for their geothermal potential, and 200MW of geothermal power are considered possible in several years.

Greece: Developing Geothermal on Island of Lesvos

After calling for geothermal exploration in October 2005, Greece's Public Power Corp. announced in October 2006 intentions to build an 8 MW geothermal power plant on the island of Lesvos, Greece.

Guatemala: Giving Emphasis to Renewable Energy

Guatemala, whose geothermal potential has been estimated at 480 MW, has succeeded in harnessing 46 MW so far in the fields of Zunil and Amatitlán, both owned by the American geothermal technology company Ormat Technologies. Feasibility studies are being carried out in the geothermal fields of Tecumburo, San Marcos, and Moyuta. Further, a 5 MW backpressure expansion at the Zunil plant is being considered.

Honduras: Beginning Development in Platanares

Honduras is looking to develop its first geothermal power plant in Platanares, outside the chains of volcanoes and high-temperature fields found along the Pacific Coast of the Central American isthmus. Geoplanares, the company holding the leases for these lands, is currently drilling exploration wells to confirm the feasibility of the site, which was first assessed in the 1980s and is expected still to be suitable for commercial development.

Hungary: Aiming High with First Plant

Hungary has been negotiating recently with American investors, hoping to develop a 65 MW plant. The company running the project, Hungarian American Geothermal Company, was recently formed and has already identified a testing site for possible geothermal development.

Iceland: Renewably Powered and Heated; Attracting New Industries

Iceland is widely considered the success story of the geothermal community. The country of just over 300,000 people is now fully powered by renewable forms of energy, with 17% of electricity and 87% of heating needs provided by geothermal energy (fossil fuels are still imported for fishing and transportation needs). Iceland has been expanding its geothermal power production largely to meet growing industrial and commercial energy demand. In 2004, Iceland was reported to have generated 1465 gigawatt-hours (GWh) from geothermal resources; by 2009 geothermal production is expected to reach 3000 GWh. The Reykjanes Power-Plant, went on line end of 2006, two turbines are producing 100 MW. The Hellisheiði Power-Plant went on line end of 2006, adding another 90 MW. Also, the Krafla power plant had expansion plans underway. Recent talks with major aluminum companies about relocating in Iceland are based upon the abundance of electricity from the nation's geothermal and hydropower resources, and could entail the construction of new geothermal power facilities to meet their needs.

India:

Studies carried out by the Geological Survey of India have observed the existence of about 340 hot springs in the country. Geophysical studies such as Magneto-telluric (MT) investigations have been/are being carried out to assess potential of geothermal fields in different parts of the country. Puga valleys in Jammu & Kashmir and Tattapani in Chattisgarh have been identified as potential sites for power generation. The Indian Ministry of Nonconventional Energy Sources continued in 2006-7 to study the

geothermal potential in the country and support development and demonstration of thermal and power generation applications, particularly hot dry rock projects.

GeoSyndcate Power Private Ltd., at the Indian Institute of Technology Bombay, are reported to be planning to generate 50 MW from the Puga geothermal field.

Indonesia: Nearly Halfway to Goal of 2000 MW

Indonesia had set a goal of producing 2,000 MW of energy from geothermal sources by 2008. At the present time Indonesia has achieved a total output short of 1,000 MW, and aggressive development plans seemed stalled. New developments in 2006 and 2007 point to renewed activity to achieve Indonesia's geothermal goals. According to recent statements, the national energy plan now envisions 2000 MW by 2010 and further expansion to 9,500MW by 2025. The country has the potential to provide enormous output, especially stemming from the West Java and Sumatra regions. However, certain factors stand in their way. Foreign investment was devastated by the financial crisis of the late 1990s, and while economic conditions have improved, investors are wary of Indonesian projects because exploration, development and fuel storage costs must be paid upfront, and investors do not see returns until the energy is sold to customers. The government in turn has implemented tax breaks and encouraged foreign investment in order to catalyze development of one of the world's largest geothermal resources.

The Indonesian energy plan envisions both expanded production from existing fields and new field development, with several new projects reported in the past two years. In 2006 Indonesia was reported to be seeking Arab investors in several geothermal projects include the Kamojang, Lumut Balai, Lahendong and Ulu Belu fields. A 60 MW construction contract was awarded for Kamojang to the Shaw Group, and development of a 110 MW geothermal power plant at Darajat, Near Garut, West Java was recently announced. Indonesia's state-owned oil and gas company, Pertamina, announced it will build three geothermal power plants with Para Group involving investment of \$1.5 billion. The plants would have a total capacity of 1,060 megawatts, but no timeline for development was made public. Also in 2006 a consortium consisting of its wholly-owned subsidiary, Ormat International, Inc., a unit of Medco Energi Internasional Tbk (Indonesia's largest private oil and gas company), and Itochu Corp. of Japan, has been declared the winner of a tender issued by the Indonesian state-owned utility PT PLN (Persero) for the development of the Sarulla, North Sumatra, Indonesia geothermal power project on an independent power producer basis. The Sarulla project is to be constructed over the next five years in 3 phases of 110 to 120 MW each, with the first power generating unit to be operational within 30 months and the last within 48 months from the financial closing. In 2007, Indonesian officials announced plans to tender seven additional geothermal areas that would generate around 575 megawatts of electricity.

Iran: First Project Under Development

Iran's geothermal development has been highly dependent on outside investment and therefore has not advanced as quickly as the programs of other countries. Their first

major project, a series of 20 wells and one 55 MW plant near the city of Meshkin-Shahr, was announced in December 2006. Iran's other venture into geothermal development was a \$100 million investment in a petrochemical plant in Bataan, located in the northern Philippines.

Kenya: See ARGeo Project

Korea: Early Development Shows Promising Results

Korea is still relatively early in its development of geothermal power, but has excelled in direct use due to government subsidies (2006 funding reached nearly \$12 million, a 100% increase from 2005). They are drilling production wells in Pohang with expected temperatures of greater than 90°C for a power project. Estimates are pending on what the expected capacity of this plant would be once it comes online. But with governmental support and continued progress, Korea has growing potential in the geothermal world.

Mexico: Thriving Geothermal Development

Mexico is currently the world's third greatest producer of geothermal energy. Generating 953 MW for around 6,600 gigawatt-hours (GWh) of geothermal energy per year, Mexico runs four major geothermal fields – Cerro Prieto (the second largest geothermal field in the world), Los Azufres, Los Humeros, and Las Tres Vírgenes - with one additional field on standby (Cerritos Colorados). Further exploration is planned for 2007 in the Acoculco (near the Los Humeros field), Domo San Pedro, and La Soledad geothermal zones.

Nevis: See OAS Eastern Caribbean Geothermal Energy Project

New Zealand: Numerous Projects Under Development

New Zealand, like Australia, has been utilizing a combination of governmental funding and investment from the private sector in order to develop its numerous projects, both planned and in mid-construction throughout the country. Geothermal resources are concentrated so heavily in the Rotorua region that the government of New Zealand has taken to calling its hot springs a “tourist location.” With a strong pillar of private investment and governmental encouragement, New Zealand is committed to harnessing the full potential of its geothermal resources. In 2006, 2006, Tuaropaki Power Company officially opened its 39 MW extension of the Mokai power station. The largest geothermal development in 20 years, the 90 MW Kawerau facility began construction. Kawerau is the first stage in Mighty River Power's plans to develop 400 MW of geothermal energy over the next five to ten years. Also, Ormat Technologies received orders from Ngawha Generation for a new geothermal power plant, once the new plant is completed Ngawha's capacity would increase from 10MW to 25 MW.

Nicaragua: Uncertain Expansion

Though Nicaragua is still in the early stages of geothermal development, the country has shown great commitment to the task, with the construction of the Polaris-owned San Jacinto Geothermal Power Project. The plant was completed in the summer of 2005, but the company announced plans in August of 2006 to expand the plant from an output of 10 MW to 31.4 MW. Enel and its partner LaGeo have been given approval to explore two geothermal areas-Chiltepe and El Hoyo Montegalán. Exploration activities hope to confirm generation potential currently estimated between 100 MW and 200 MW.

With the re-election of Daniel Ortega after his defeat in 1990, it remains to be seen if any major changes will be made to Nicaragua's geothermal program, but so far his only act has been to create a new ministry to handle the geothermal bidding process.

OAS Eastern Caribbean Geothermal Energy Project

Nevis: Exploration Moving Ahead

A proposed geothermal project for Nevis has entered the phase where the Organization of American States (OAS) is seeking to raise US\$10 million for the actual exploration and drilling in an attempt to develop geothermal energy available on Nevis. Earlier this year (2007), the Nevis Island Administration (NIA) announced they have given their approval for West Indies Power (WIP Nevis) Ltd. to begin geothermal energy exploration on Nevis.

St. Lucia and Dominica

With support from the OAS Eastern Caribbean Geothermal Energy Project, efforts to explore and develop geothermal energy in both St. Lucia and Dominica were reported as moving forward at their consultation in March 2006.

Papua New Guinea: Using Geothermal to Power Industry

Geothermal electricity production in Papua New Guinea comes entirely from the small island of Lihir, located 700 kilometers north of the capital. In 2005, 6 MW of power from geothermal energy were online, now a new group of geothermal units are online, bringing the total power production to 56 MW, an 833% increase in less than two years. Currently, geothermal power goes mainly towards gold mining projects, which derive 75% of their power needs from geothermal energy, allowing mining companies to save an estimated \$40 million USD this year alone. Additional revenue will come from the sale of carbon credits, which could bring in roughly \$3 million USD per year.

Philippines: Expanding Power Production 200 MW

The Philippines have made an extraordinary effort in the past few years to achieve the ambitious goal they have set: to become the world's leading geothermal energy producer sometime in the next two decades. The Philippine National Oil Company, Energy Development Corp. (PNOC-EDC) has been seeking foreign investment to accomplish

this, drawing from the World Bank and allowing private firms from around the world to bid for ownership of plants they have planned to build in areas all over the Philippines. Areas of major development include Northern Negros (one 49 MW plant), Southern Leyte (two planned 50 MW plants, built to alleviate power outages in the Visayas region), and Bago (one 49 MW plant), in addition to many planned projects that will require supplemental fundraising to be constructed. In February 2007, the commissioning of the Northern Negros plant made Negros Island the first region in the Philippines to be completely powered by renewables, 99.6% of which came from geothermal sources.

Portugal: Azores Prove to Have Geothermal Potential

Ormat currently runs a number of geothermal power plants on the island of Sao Miguel in the Azores Islands. Resources are high, and Ormat's success has opened the gates for more development in the future.

Russia: Rekindling Old Flames

In July 2005, after committing to explore renewable forms of energy to power their grid, Russia announced plans to rebuild their first geothermal power plant—the Puzhetskaya plant, built in 1966—in the Kamchatka region. In addition studies of additional production from the Mitnovsky field, and hot dry rock production from the Avachinsky volcano are underway.

Rwanda: See ARGeo Project

Slovakia: Starting to Harness Geothermal

In April 2005, Iceland and Slovakia drew up plans to build a geothermal power plant in Kosice, Slovakia.

Solomon Islands: New Cooperation

There has long been interest in geothermal energy in the Solomon Islands, and development may move forward with the establishment of diplomatic relations between the Islands and Iceland in 2007. As part of the diplomatic agreement, the countries “agreed to have Icelandic geothermal experts to examine geothermal potential on some of the country's volcanic islands.”

St. Lucia: See OAS Eastern Caribbean Geothermal Energy Project

Switzerland: EGS Systems are Switzerland's Key

Switzerland does not produce electricity from geothermal power yet, but has a well-established base (656 MW) in direct use through heat pumps. Further, the country is beginning to explore different approaches to move towards electricity production. The Swiss Federal Office of Energy recently began funding Geothermie, formerly known as

the Swiss Association of Geothermal Energy (SVG), in the areas of “Research and Development” and more generally “Activities of the SVG.” Switzerland is also testing sites at Basel and Geneva for enhanced geothermal systems (EGS), using a deep heat mining method to try and begin producing electricity from geothermal energy.

Taiwan: Renewed Interest

Researchers reported renewed interest in geothermal power development prospects for Taiwan in the Chinghui geothermal field, but deep well drilling to confirm energy potential was said to be needed.

Tanzania: See ARGeo Project

Turkey: Significant Potential and Rising Development

Turkey is the 7th most promising country in the world in terms of geothermal potential. Research is ongoing, but reliable estimates of Turkey’s potential have been placed at 31,500 MW. Turkey is harnessing geothermal heat for direct use in a number of different applications, including residential heating, greenhouse heating, thermal tourism (one of Turkey’s tourist attractions is its geothermal-heated baths), and part of the industrial sector (a liquid carbon dioxide and dry ice producing factory.) Currently, Turkey has drilled hundreds of wells, seeking not only to take on more high-temperature projects, but also to explore the possibility of developing hot dry rock (HDR) projects and further develop low-temperature applications like the direct use systems that are already in place.

Uganda: See ARGeo Project

US: Still World’s Leading Geothermal Energy Producer

The United States continues to be the world leader in online capacity of geothermal energy and the generation of electric power from geothermal energy. According to federal energy data, in 2005, geothermal energy provided approximately 16 billion kilowatt hours (kWh) -- 0.37% of the electricity consumed in the U.S. As of November 10, 2006, geothermal electric power was being generated in 5 U.S. states: Alaska, California, Hawaii, Nevada, and Utah.

In the United States, a new wave of geothermal development appears to be underway, propelled by Congress enacting in 2005 a new federal tax incentives (the production tax credit) for geothermal energy and continued initiatives to expand renewable energy production by state governments, principally renewable portfolio standards. According to GEA’s survey in November 2006, there were 61 projects at different stages of development. These projects would produce between 2,100 and 2,400 MW once developed, and would expand US geothermal power production from 5 to 9 states. Since then, additional projects have been identified in Wyoming and Texas.

Vietnam:

The Vietnam Science and Technology Institution held a geothermal conference in 2005, the outcome of which was reported to be "...that scientists expected the Vietnamese government to start developing Vietnam's geothermal energy sources soon." While there are no reports of projects actively moving forward, the October 2007 national energy fair does include geothermal among technologies to be examined to address Vietnam's "inadequate power supply situation."

Yemen: Geothermal Exploration Moving Ahead

In November 2006, Yemen announced intentions to develop geothermal power. A month later, an agreement was signed to allow geothermal exploration to begin in the Dhamar - Rada'a area.

Countries Generating Geothermal Power in 2000 (21)

Australia, China, Costa Rica, El Salvador, Ethiopia, France (Guadeloupe), Guatemala, Iceland, Indonesia, Italy, Japan, Kenya, Mexico, New Zealand, Nicaragua, Philippines, Portugal (Azores), Russia, Thailand, Turkey, United States

Countries Adding Power Generation by 2005 (3 for a total of 24)

Austria, Germany, Papua New Guinea

Potential New Countries by 2010 -- Based Upon 2007 Interim Survey (22 for potential total of 46)

Armenia, Canada, Chile, Djibouti, Dominica, Greece, Honduras, Hungary, India, Iran, Korea, Nevis, Rwanda, Slovakia, Solomon Islands, St. Lucia, Switzerland, Taiwan, Tanzania, Uganda, Vietnam, Yemen

Figure 1: Trend Lines for Geothermal Power

