May 2012

Geothermal:

International Market Overview Report

KENYA

TURKEY

NEW ZEALAND

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GEA has prepared this document to provide the interested public with a sample of the range and complexity of the international geothermal power market in May of 2012. The report was not able to include information on many countries where there is geothermal production, development and exploration taking place. We appreciate the many people in those countries whose efforts to expand geothermal energy production and use deserve recognition.

The 2012 International Market Overview Report is a brief follow-up on the more in-depth report by the Geothermal Energy Association released in 2010. Although geothermal energy production includes heat as well as power, the 2010 report and the 2012 follow-up report primarily describe recent developments in the power market. To view the 2010 report, see *GEA International Market Report Final* (May 2010) at: http://geo-energy.org/reports.aspx.

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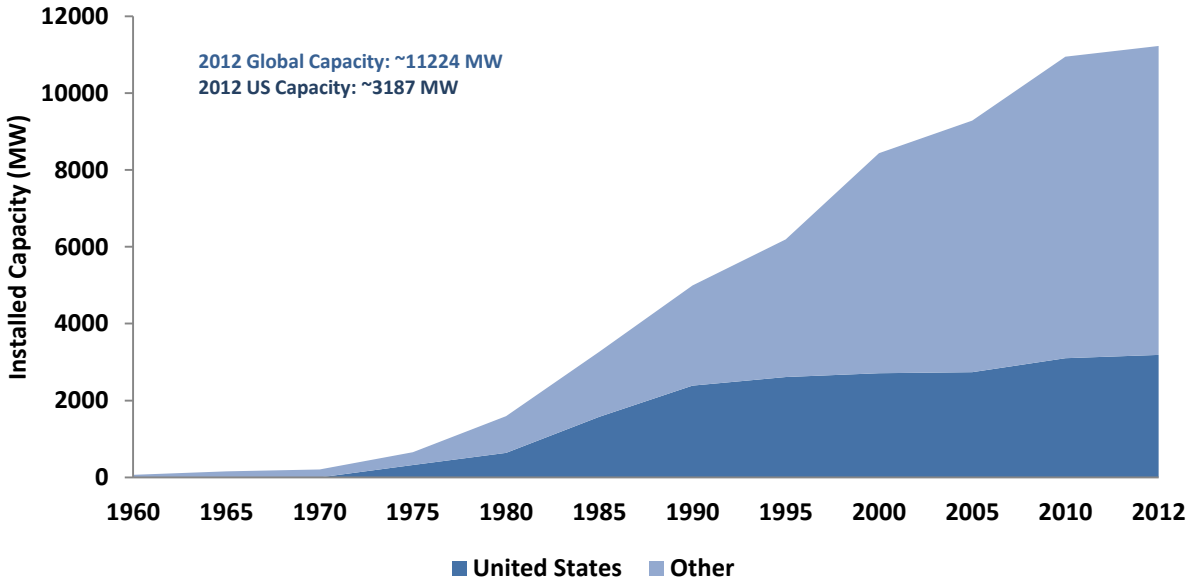
2012 International Market Overview Report

GLOBAL OVERVIEW

The global geothermal power market continued to grow substantially in 2011-12, outpacing the US geothermal market by a noticeable margin. As of May 2012, approximately 11,224 MW of installed geothermal power capacity was online globally. In 2010 geothermal energy generated twice the amount of electricity as solar energy did worldwide.[1]

Geothermal growth is currently fueled by a number of factors: economic growth, especially in developing markets; the electrification of low-income and rural communities; increasing concerns regarding energy security and its impact on economic security. Additionally, the majority of the growth in the development of global geothermal resources is occurring in countries with large, untapped, conventional resources. As more countries recognize and understand the economic value of their geothermal resources, their development and utilization becomes a higher priority.

Figure 1: Global Context of US Geothermal Installed Capacity 1960 – 2012



Source: GEA

New technology appears to be underpinning geothermal expansion in some regions which have already seen significant development of their conventional resources. In the US and Europe, for example, the geothermal industry is increasingly using binary technology that can utilize more moderate and low temperature resources to generate electricity. Also, energy and economic security are compelling drivers for the adoption of policies supporting geothermal development in countries like Chile and Japan. In nearly every case, national policies are propelling growth in the strongest markets, while the current world leader – the US – appears to be growing more slowly due to policy uncertainties.

This report highlights geothermal resource development in certain countries, as well as the policy and economic drivers behind that development. The market trends observed will be the object of more thorough analysis in future studies.

Africa

A number of factors are leading certain countries in Africa to explore the viability of developing the continents geothermal resources. First, Africa has the smallest amount of energy use of any populated continent in the world. Only approximately 25 percent of Africa's population has access to electricity, more than half of which is traditional biomass which contributes to deforestation and health problems. Increasing demand for electricity also adds impetus to the need to increase access to electricity in Africa. At the same time, increasing demand for electricity exacerbates issues currently associated with Africa's electricity sector. For example, reliance on imported petro-products for thermal power generation exposes African countries to the price volatility of fossil fuels. Additionally, due to climactic fluctuations, the reliability of hydropower as a primary source of electricity for many African countries has been called into question.

Africa's geothermal resources are concentrated in the East African Rift System (EARS comprises the Democratic Republic of Congo, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mozambique, Rwanda, Tanzania, Uganda, and Zambia) and remain largely undeveloped. Currently, only approximately 217 MW of geothermal resources have been developed in Kenya and Ethiopia for electricity production. The estimated potential of geothermal resources in EARS is more than 15,000 MW.[2]

Ethiopia

Between 2005 and 2010 Ethiopia's gross domestic product (GDP) grew by 11 percent annually. In order to perpetuate economic growth into the next decade Ethiopia's government has established a plan for the country to achieve middle income economic status by 2025, while at the same time developing a carbon neutral economy. A major pillar of Ethiopia's plan for economic growth is the expansion of renewable energy generation, including geothermal.[3]

Currently, Ethiopia is home to only one operating geothermal power plant; the 7.3 MW Aluto-Langano plant located in the country's south. However, Ethiopia's geothermal resource capacity has been estimated at 5,000 MW, and the country's government has grown increasingly interested in developing its geothermal resources. In 2009 Ethiopia's Ministry of Mines and Energy signed a Memorandum of Understanding (MOU) with Marubeni Corporation for the Japanese Company to conduct survey work for the expansion of the Aluto-Langano geothermal plant.[4] In 2010 the World Bank granted a US$ 330 million loan to Ethiopia, a portion of which the country intends to use for the development of geothermal resources.[5] Ethiopia has also received funding for the Aluto-Langano geothermal project, which plans to expand generation capacity at the power plant from 7.3 MW to 70 MW.[6]

Kenya

Geothermal energy is positioned to play a central role in Kenya's plans for economic growth and transformation into a middle-income country. Obstacles to Kenya's economic growth include an overreliance on imported petroleum products used in thermal generation, as well as hydropower. The former exposes Kenya to price variability while the reliability of the latter is subject to changes in the local climate. The result is an electricity sector that is unreliable and prone to power shortages. One World Bank study indicates that the disruption of public power supply costs Kenyan companies about 7 percent of their annual sales revenues.[7] Kenya's power sector is also reliant on traditional biomass,

which has led to deforestation. To increase the robustness and reliability of its power sector Kenya has set ambitious geothermal energy goals.

It is estimated that Kenya possesses at least 7,000 MW of the geothermal resource potential.[8] Of this, approximately 202 MW have already been developed for power production by state-owned Geothermal Development Company (GDC), as well as some private companies. GDC was established in 2004 to drive further development of its geothermal resources Kenya has set a goal to produce 5,000 MW of energy from geothermal resources by 2030.[9] GDC was established in 2004 to fast-track geothermal resource development and a significant part of GDC's plan to drive the development of Kenya's geothermal resources is to explore and gather data on various geothermal sites. GDC also owns and operates geothermal drilling rigs with which it can drill full size discovery wells to confirm the presence of commercially viable geothermal resources. By conducting up-front exploration and drilling itself, GDC assumes a significant portion of the risk associated with geothermal development, and is then able to open up geothermal resources to the private sector for further development.

At least 14 geothermal sites have been identified for development in Kenya. Of these, the Olkaria and Menengai fields have been some of the most prolific in terms of development activity. GDC estimates the Olkaria geothermal resource potential to be 1000 MW, and three power plants (Olkaria 1, 2, and 3), operated by the Kenya Electricity Generating Company (KenGen) and Ormat Technologies, have already been installed there. GDC is currently drilling production wells at the site for Olkaria 4, a 140 MW plant. While no power plants operate at the Menengai geothermal field, GDC is currently conducting exploration drilling there. GDC puts resource estimates for the Menengai geothermal resource at 1,600 MW.[10]

Tanzania

Geothermal energy has the potential to play a significant role in the growth and modernization of Tanzania's electricity sector. Currently, approximately 14 percent of Tanzania's population has access to electricity, while the majority the population's energy usage (approximately 90 percent) is fueled by biomass. Tanzania expects that growth in its residential, commercial, and industrial sectors will triple demand for electricity by 2020. Currently, there are 1219 MW of installed electricity capacity in Tanzania. Of this installed capacity, 561 MW are hydropower plants, which often force the country to ration power during periods of drought.[11]

To help drive economic growth and modernize its electricity sector, in 2003 Tanzania enacted its National Energy Policy supporting the research and development of its domestic renewable energy resources.[12] While more exploration of the country's geothermal resources is needed, it is believed that significant potential exists. For example, the Tanzanian Ministry of Energy and Minerals has estimated that as much as 650 MW of geothermal resources exist in the Mbeya region.[13]

Geothermal developers have recently shown active interest in exploring and developing Tanzania's geothermal resources. Geothermal Power Tanzania (GPT) Ltd has been exploring the Mbeya regions geothermal resources and expects to begin drilling there either in 2012 or 2013. According to GPT, exploration and drilling is occurring along the Mbaka and Livingstone faults areas, both of which are expected to support 10 MW geothermal power plants.[14] GPT is partnering with the Tanzania National Development Corporation, the Tanzanian mining company Interstate Mining and Minerals, Mauritius based Geothermal Power Ltd, and German Geothermal Engineering.[15]

Asia and the Pacific

Countries in Asia and the Pacific Islands are poised to make a significant contribution to the growth of the global geothermal industry. High-grade resources and friendly policy environments have resulted in an emergence of advanced-stage geothermal projects that are beginning to attract the expertise of geothermal developers as well as the interest of project financiers. The potential for the development of geothermal resources throughout the region is immense. Countries featuring in the growth of Asia's geothermal sector are Indonesia, the Philippines, and Japan where state efforts to provide policies and regulatory environments that incentivize the development of geothermal resources are increasingly attracting the interest of geothermal companies throughout the world.

Indonesia

A rapidly growing economy and increasingly urbanized population are contributing to increased electricity demand in Indonesia. By certain estimates Indonesia's electricity demand will increase by 7 to 9 percent annually for the foreseeable future. Additionally, it is estimated that approximately 80 million people in Indonesia currently have no access to electricity, giving it one of the lowest electrification rates in the region at 66 percent.[16]

Indonesia has abundant geothermal resources which it can use to help meet rising electricity demand and increase electrification. With 27,510 MW of potential resources, Indonesia's estimated conventional hydrothermal geothermal resource base is among the largest in the world. Moreover, most geothermal systems in Indonesia are considered to be high temperature (i.e. >250°C), and ideal for electricity generation.

Indonesia is eager to develop its geothermal resources and has set a goal to increase the amount of its installed geothermal capacity to 5000 MW by 2025. Additionally, the Indonesian government has implemented a series of laws and regulations to promote the development of its geothermal resources. In 2003 Indonesia streamlined the regulatory process by which geothermal exploration permits are granted to developers in a competitive bidding process. The country has also implemented laws exempting equipment imported into Indonesia for geothermal development from certain taxes and custom duties. Lastly, in 2011 the Indonesia government required its state-owned utility PT Perusahaan Listrik Negara (PLN)to purchase electricity from geothermal power plants at the maximum price of US$ 0.97/kWh.

Indonesia's geothermal resources have attracted the attention of international geothermal resource development companies as well as the support of its national government. Both Indonesian and foreign companies are developing geothermal resources throughout the country's islands. Currently, at least 44 geothermal projects are in development in Indonesia. Of these projects, 11 are being developed by PLN, and 33 are being developed by independent power producers. The World Bank is working with the government of Indonesia to fast track two geothermal projects (one on the island of Sumatra and the other on the island of Sulawesi) by providing US$ 300 million in low interest loans to the project.[17]

Japan

Over the past decade, efforts to develop additional geothermal power plants in Japan had been minimal as the national policy favored production of electricity from nuclear power. However, in the wake of the Fukushima disaster Japan's government reassessed its energy policy and is shifting its focus from nuclear energy to power production from renewable energy resources such as solar, wind, and geothermal power.

In order to drive the development of renewable resources, the Japanese Ministry of Economy, Trade and Industry (METI) is considering a plan to implement feed-in tariffs for renewable technologies. Under the current proposal, the feed-in tariff for geothermal energy generation in Japan would be set at approximately 0.53 US$/kWh and 0.35 US$/kWh for power plants with less than 15 MW and greater than 15 MW of installed capacity respectively. The tariffs will be opened to public comment after METI issues a rule on them at the end of May 2012. The tariffs are expected to go into effect in July 2012.[18] Japan has twenty operating geothermal power plants with a total installed capacity of 535 MW.

Geothermal is responsible for approximately 0.2 percent of electricity generation in Japan, but with an estimated 23,000 MW of geothermal energy, opportunities to further develop Japan's geothermal resources abound. Until recently, access to Japans geothermal resources was restricted due to the fact that a significant portion is located within national park land. However, in March 2012 Japan's Ministry of the Environment stated that, under certain conditions, it would allow vertical drilling for geothermal resources in its national parks. Easing the restrictions on geothermal drilling in national parks alone could open up 1,000 MW of geothermal resources to development according to one estimate.[19]

The energy industry appears ready to take advantage of Japans renewed appetite and support for domestic geothermal energy development. A group of Japanese companies including Idemitsu Kosan Co., Inpex Corp., Mitsubishi Materials Co., Japan Petroleum Exploration Co., and Mitsubishi Oil Exploration Co. have formed a consortium to develop up 270 MW of geothermal resources in Fukushima.[20]

Philippines

A growing population and economy are driving the need for increased development of the Philippines energy resources and infrastructure. Economic growth in the Philippines has averaged 5 percent in the past 10 years, with growth reaching as high as 7.6 percent in 2010. The Philippines Department of Energy anticipates that demand for electricity will double in the next 20 years fueled by growth in its industrial and transportation sectors.[21]

In the midst of this growth the Philippines' energy sector has been confronted with challenges. A reliance on hydropower in certain regions makes the country vulnerable to drought induced power shortages.[22] Additionally, central and southern parts of the Philippines suffer from lack of access to reliable generation and electricity prices remain high throughout the country.[23]

In order to meet growing electricity demand, reduce dependency on fossil fuels, and increase its energy overall energy security the Philippines is promoting the development of its renewable energy resources, including geothermal. In its 2009 – 2030 Energy Plan, the Philippines set a target to increase operating geothermal capacity from 1,972 MW to 3,447 MW for an increase almost 1500 MW.[24] To facilitate the development of its geothermal resources, the Philippine government has taken a number of steps to

open the development of its geothermal resources to the private sector. In 2001 the government privatized the National Power Corporation's geothermal generating assets. To further open its geothermal market to private participation, the Philippines established a competitive bidding process for geothermal exploration projects in 2008, and legally defined geothermal resources as mineral resources, which enabled the participation of foreign companies in geothermal exploration and development.[25]

The increasing demand for electricity, government support, and ample resources are driving the development of geothermal energy in Philippines by a number of companies. In 2011 the Philippines government approved six geothermal power contracts for Pan Pacific Power Philippines Corp. and SKI Construction Group Inc.[26] Recently, Maibara Geothermal, Inc. began the development of its Maibara geothermal project, which is expected to bring 20 MW of geothermal electricity online in 2013.[27] Additionally, Energy Development Corporation, a Philippine company, is currently rehabilitating its Bacon-Manito, Palinpinon, and Tongonan geothermal power plants in the Philippines to ensure ongoing geothermal generation there.[28]

China

China, one of the largest energy consumers in the world, issued its "greenest" five-year plan in 2011. The 2011-2015-plan includes targets to raise the share of non-fossil fuels in energy consumption to 11.4 percent and the carbon emitted per dollar by 17 percent.[29] China's push to increase its generation of renewable energy could have a favorable impact on the geothermal sector there. China has 12 major geothermal basins, amounting to an equivalent of 853 billion tons of common coal, which could generate around 7 billion GWh of electricity.[30] Despite ranking first in the world in the use of geothermal resources for all applications, as of 2010 China ranked only eighteenth in geothermal electric power capacity, with only 24.2 MW installed.[31] China forecasts 60 MW of installed geothermal energy capacity for electricity production by 2015, up from the current 24 MW installed.[32]

Several obstacles stand in the way of China reaching its geothermal goals. First, most of China's known high-temperature resources are located in only two provinces – Tibet and Yunan.[33] Closely tied to this issue is the fact that China has not done sufficient exploration to have full understanding of its geothermal resources, which impedes further development. Also, China does not yet have enough experts to support necessary geothermal technology R&D or deployment.[34]

To address obstacles to the development of its geothermal resources, China has sent several students to participate in the UN Geothermal Training Program in Iceland, a program that has been running for over 30 years.[35] As a further expression of China's interest in geothermal energy, Prime Minister Wen Jiabao's visit to Iceland in April 2012 included a stopover at a geothermal power plant.[36] Wen Jiabao and his Icelandic counterpart Prime Minister Johanna Sigurdardottir witnessed the signing of an agreement to expand collaboration and knowledge-sharing for geothermal energy between the Chinese Sinopec Group and the Icelandic company Orka Energy Holding. The agreement includes expanded cooperation in harnessing geothermal energy for heating, electricity production and other related projects.[37]

Central America and the Caribbean

Geothermal energy stands to play a key role in the economic growth of Central America and Caribbean countries. In Central America rapid economic growth, increasing dependence on imported fossil fuels, and a push to overcome regional fragmentation through the SIEPAC (Sistema de Interconexion Electrica para America Central) transmission interconnection[38] have created the need for the development of the region's renewable resources. The majority of countries in Central America have developed a portion of their geothermal resources for utility scale power production. El Salvador and Costa Rica derive 24 percent (204 MW) and 12 percent (163 MW) of their electricity production from geothermal energy respectively. Nicaragua (87 MW) and Guatemala (49.5 MW) also generate a portion of their electricity from geothermal energy. The potential for further development of Central America's geothermal resources remains significant, and the geothermal potential of the region has been estimated between 3,000 MW and 13,000 MW at 50 identified geothermal sites.[39] Additionally, geothermal energy in Central America is competitive with the region's primary forms of electricity generation; hydropower and thermal generation from fossil fuels.

Caribbean Islands

Many countries in the Caribbean are projected to experience significant growth accompanied by an increase in demand for electricity. According to the World Bank, demand for electricity in a key number of Caribbean countries is expected to grow at approximately 3.6 percent through 2028. In addition to the increasing electricity demand, utilities in Caribbean countries face high operating costs, which contribute to some of the world's highest electricity prices. Also, the majority of electricity generation in the region is provided by diesel and heavy fuel oil.[40]

Geothermal energy has the potential to help meet the Caribbean's rising electricity demand, mitigate its high electricity prices, and make it less dependent on fossil fuel generation. Dominica and Nevis provide an example of how geothermal energy can help improve their energy situations. Geothermal resource estimates for both islands (100 MW and 300 MW respectively) are large enough to indicate that geothermal energy could meet electricity demand on both islands. Most importantly, the cost of geothermal electricity would be a significant improvement over costs associated with current fossil fuel generation. According to the World Bank, the lowest-cost fossil fuel option is 20.4 US$ cents/kWh, whereas the cost of geothermal is estimated at 5.5 US$ cents/kWh. As such, the potential net benefit of switching from diesel fueled to geothermal generation would be approximately 15 US$ cents/kWh. While electricity demand on Dominica and Nevis is not currently large enough require large additions of geothermal capacity, the potential economic benefit to each of the islands economies is obvious.[41]

Table 1: Comparison of Diesel and Geothermal Generation in Dominica and Nevis

Technology	Capacity (MW)	Capacity Factor (%)	Cost (US$ cents/kWh)
Diesel	5	80	20.4
Geothermal	20	80	5.5
Net Benefit:			**14.9**

Source: World Bank

Governments and private companies are showing interest in the development of the Caribbean's geothermal resources. In the latter half of 2011, Dominica granted permits to Icelandic firms Iceland GeoSurvey and Iceland Drilling to conduct geothermal exploration and drilling for geothermal resources there. Financial backing of the exploration project was provided by the Dominican government as well

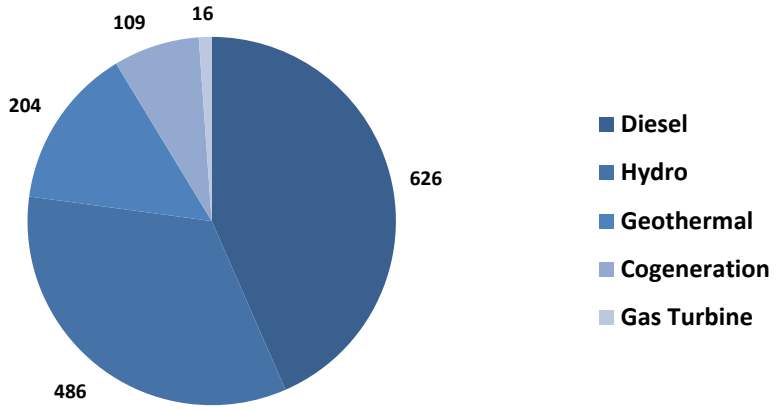
as the French Development Agency (FDA) and the European Development Fund (EDF).[42] Initial drilling results in Dominica have been promising, and the country recently signed a memorandum of understanding with the International Finance Corporation (IFC) for US$ 250,000 of initial funding for geothermal development there.[43]

Opportunities for geothermal development exist elsewhere in the Caribbean. In April 2012 the government of Montserrat announced that it entered into a MOU with the United Kingdom's Department for International Development for financial support for geothermal exploration drilling over the next year.[44]

El Salvador

Geothermal energy plays an important role in El Salvador, generating approximately 24 percent of the country's electricity. Still, El Salvador is primarily dependent on thermal generation from imported oil for the majority of its electricity (approximately 44 percent of total generation in 2009), making it vulnerable to volatility in fossil fuel prices.[45]

Figure 2: Installed Generation Capacity in El Salvador (MW)



Source: World Bank

Substantial geothermal resources, in-country geothermal expertise, and a supportive regulatory environment put El Salvador in a position to replace thermal generation from imported oil with geothermal energy. Estimates of El Salvador's geothermal potential range from 362 MW to 2,210 MW, indicating that potential for expansion of the resource is substantial.[46] El Salvador has also developed the in country expertise to ramp up development of its geothermal resources in the near-term. Additionally, the country recently received a US$ 2 million grant from the Inter-American Development Bank to found an international geothermal training center for Latin America and the Caribbean, which will help train representatives from El Salvador and countries throughout the region to develop and operate geothermal facilities.[47]

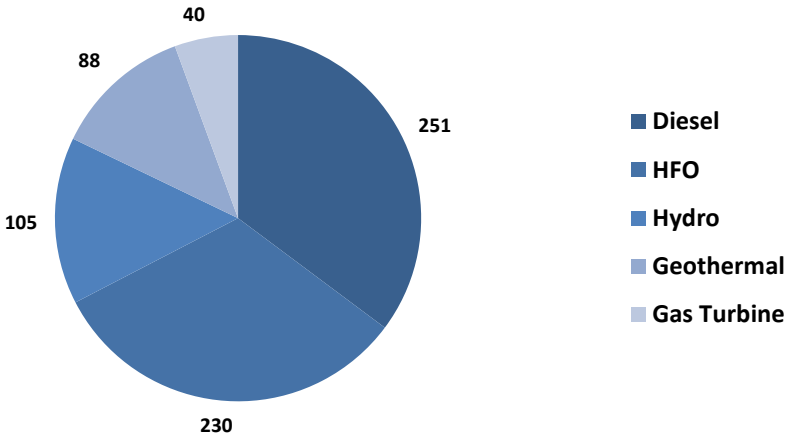
Geothermal development in El Salvador falls under the purview of state owned La Geo, a mixed capital enterprise partnership between the Salvadoran government and Italian power company Enel. La Geo has experience in exploring for and developing El Salvador's geothermal resources, and is also able to draw upon the expertise and financial resources of Enel. Additionally, planning for the accommodation of new generation capacity in El Salvador is the responsibility of the National Energy Council, which

places a prioritization on including geothermal and other renewables in the country's energy mix. Lastly, El Salvador's regulatory institution, SIGET, has the ability to enforce power purchase agreements (PPA) that are financially favorable to private developers.

Nicaragua

The development of geothermal resource in Nicaragua would help to address a number of energy issues facing the county. With approximately 55 percent of its population connected to the grid (92 percent of which reside in urban areas), Nicaragua has the lowest electricity coverage of any country in Central America.[48] Additionally, Nicaragua has become heavily dependent on fossil fuels for electricity generation. Thermal generation using fuel oil supplies over 60 percent of Nicaragua's electricity, making the country economically vulnerable to fossil fuel price volatility.[49] In an effort to address these issues, the Nicaraguan government has set a goal to produce 94 percent of its electricity from renewable resources by 2017, and 100 percent by 2025.

Figure 3: Installed Generation Capacity in Nicaragua (MW)



Source: World Bank

As part of its effort to increase renewable energy generation, Nicaragua is eager to support the development of its geothermal resources. In 2002 Nicaragua instituted Geothermal Law 443, which regulates the exploration and development of geothermal resources by private companies. While, significant geothermal potential still remains to be exploited in Nicaragua, recent development in the country has occurred. In December 2011, Ram Power Corp., a Reno, Nevada based geothermal developer, completed the first phase of its expansion to the San Jacinto geothermal resource, bringing 36 MW of geothermal capacity online. Ram Power expects to bring an additional 36 MW online at San Jacinto in December 2012. Ram Power is also conducting exploration of the Casita San Cristobal geothermal resource in northwest Nicaragua. It is believed that the geothermal resource, if found to be commercially viable, could support 85 MW of geothermal generation.[50]

South America

In the past few decades South America has at times enjoyed economic growth due to the development and exportation of its oil and gas resources. However, economic and diplomatic issues surrounding the flow of energy across borders have had adverse impacts on the economies of South American countries.[51]

For example, Argentina abruptly cut off supply of natural gas to Chile in mid-2004; and a transmission line built a few years ago to connect Peru and Ecuador has rarely been used due to disagreement on electricity price.[52] Reports of blackouts and worker strikes have become increasingly regular. At the same time, energy consumption and demand is growing in South America and is projected to increase by 72 percent through 2035(includes Central America), according to the EIA.[53]

Awareness of climate change issues is another factor leading many of these countries to seek development of renewable resources. The melting of Andean glaciers and changing rain patterns have negatively impacted local agriculture and residential patterns thanks to the dwindling water supply.[54] The United Nations predicts that Latin American countries will be severely affected by climate change, despite the fact that the region's greenhouse gas emissions represent a small proportion of total global emissions.[55]

To address the of issues energy security, increasing demand, and sustainability, some countries in South America have taken steps to increase domestic energy security by supporting the development of their renewable energy resources.

Geothermal resources represent an opportunity to meet energy needs with a clean, baseload, sustainable form of energy in South America, particularly along the Andean Mountain Range and the Southern Cone of the continent. Experienced companies from Australia, Italy, the US, and other countries are taking an interest in the development of South America's geothermal resources. Many are partnering with a resident company, bringing local understanding to the project as well as making development more feasible. Some local and international mining companies have undertaken smaller-scale operations, working to develop geothermal resources to help meet the electricity needs of their operations.

A key player in development financing for renewable energy throughout Latin America and the Caribbean is the Inter-American Development Bank (IDB). Already contributing to some geothermal projects, such as the Copahue project in Argentina, the bank's recent efforts seem to redouble its commitment to climate-friendly solutions: thus far it has approved US$ 30 million for renewable energy projects for the Emerging Energy Latin America Fund II,[56] had an additional US$ 70 billion capital injection,[57] and began a five-year target to use 25 percent of its loans toward climate-related projects.

Argentina

Argentina traditionally relies on fossil fuels and hydropower generation, as well as natural gas. Like other countries in the area, Argentina went through a time of privatization in the energy sector, which kept renewable technologies comparably uncompetitive and left holes in energy supply to rural areas. In the latter 00s the government stepped up its involvement; new renewable energy projects are

receiving government finance through trust funds, and in 2010, new investment in renewables in the country increased almost sevenfold to US$ 740 million.[58]

In its renewables policy incentive scheme Argentina uses feed-in tariffs, given for 15 years after a plant is brought on line, as well as competitive bidding and long-term tendering.[59] Though a 1998 law supported wind and solar generation, geothermal did not become eligible as a renewable energy source until 2007. More recent additions include tax exemptions, and the country set a mandate for electricity generation from renewable sources to reach 8 percent of the portfolio by 2016. In May 2009, the Genren Program was launched, aiming to purchase and incorporate 1,000 MW from renewable energy plants, 30 MW of which is to come from geothermal energy.

Argentina has some particularly unique geothermal finds, such as a newly discovered Jurassic-era organic deposit. No geothermal power plants are currently operating in Argentina, but Earth Heat Resources (Australia) is working toward a June 2012 completion date[60] at its flagship Copahue project and has signed a PPA with Electrometalurgica Andina SAIC for an initial 30 MWe/year. IDB is a major investor.[61]

Chile

In Chile, issues such as increased energy consumption and demand as well as shortages of natural gas imports undermine Chile's energy security while it continues to rely on hydropower and fossil fuels for electricity. In 2009 the US Department of Energy (DOE) and the Chilean National Energy Commission established an institutional framework for collaboration between the two nations and to develop a Renewable Energy Center in Chile.[62]The initiative's aim is to identify developments and best practices in renewable energy technologies from around the world and then incorporate those findings in the region.

The Chilean government's response includes offers of renewable energy concessions to local and foreign developers. A tender that just closed in April 2012 for 20 geothermal energy exploration concessions generated US$ 250 million in committed investments from thirteen firms, including Enel Green Power (Italy, via Geotermica del Norte, Chile), Origin Energy (Australia), Alterra Power Corp. (Canada), Ormat Technologies (US, via Ormat Andina, Chile), GeoGlobal Energy LLC (US, via GGE Chile), and Colbún (Chile).[63]

In addition acquiring geothermal concessions, foreign and Chilean companies are engaged in moving a number of projects throughout Chile through stages of permitting, exploration and development. For example, the first completed geothermal facility in South America seems likely to come from Enel, which is close to entering the construction phase on its 40-MW Cerro Pabellón, Pampa Apacheta geothermal project in the Antofagasta region.[64] Enel also recently acquired the Colorado, San Jose I, and Yeguas Muertas concessions.[65] GGE Chile could break ground in mid-2013 for a geothermal power plant at the Curacautin prospect in southern Chile and bring it on line by early 2016. The company has submitted an environmental impact assessment for a 70-MW geothermal project planned at US$ 330 million.[66]

Energy Development Corp.'s (Philippines, via EDC Chile)'s interest in Chile's resources led to applications for over a dozen concessions in 2011, and the company is about to begin geological and geophysical surveys at the Newen site.[67] The company has recently partnered with Australian geothermal company Hot Rock in the exploration and development of geothermal prospects in Chile and elsewhere. Transmark (The Netherlands, via Transmark Chile SpA) and ECM SA (Chile, via ECM Geothermal SpA)are jointly developing strategies for geothermal resource development, with exploratory drilling to begin by

the end of 2012.[68] Elsewhere in the country, Origin Energy recently purchased a 40 percent stake in Energia Andina, a Chilean geothermal exploration company owning permits for eight projects;[69] and Ormat was awarded five new exploration concessions: Aroma, Quinohuen, Marimar, San Jose II, and Sollipulli.[70]

Peru

Currently, electricity generation in Peru comes mainly from fossil fuel and hydro sources and has seen a rise in natural gas production in the Amazon Rainforest. Like Argentina, the government has targeted rural areas that are in need of energy supply. Legislation from the Peruvian government is becoming friendly to renewable development, including a mechanism for setting feed-in tariffs and tax incentives for renewable energy. The government has conducted renewable auctions, including for geothermal, and has a goal for the country to reach 5 percent of electricity from renewable sources by 2014. In 2010, investment in renewables in the country more than doubled to US$ 480 million.[71]

Hot Rock holds exploration sites in Peru, and with investment group Andes Power received authorization to drill in the southern Andes.[72] Hot Rock with EDC, which also work together in Chile, announced joint ventures in Quella Apatcheta and Chocopata, Peru.[73] Additionally, Magma Energy (now part of Alterra Power Corp.) recently acquired geothermal concessions in the country.[74]

North America

The principal countries of North America – Canada, Mexico and the US – have some of the highest standards of living in the world, as well as high electricity demand and degrees of electrification. However, the continent is also relatively well supplied with fossil and other conventional energy resources. Moreover, neither Canada nor the United States has adopted national climate policies and neither is currently a signatory to the Kyoto protocol.

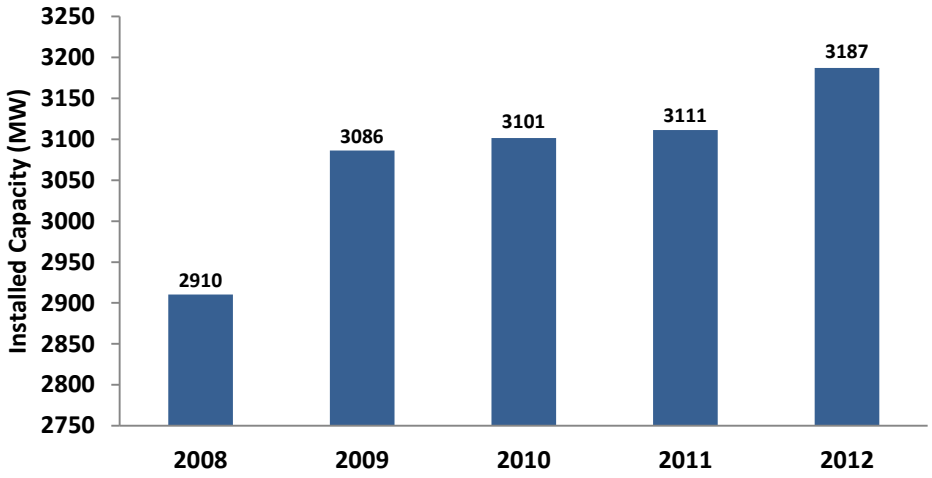
While North American countries may not be as exposed to the same factors incentivizing emerging economies to develop their renewable resources, there is still a strong case for the increased implementation of geothermal energy into their economies as well. In the US, coal and natural gas respectively generated approximately 42 and 25 percent of total electricity generated in 2011, indicating that North American economies are also vulnerable to the adverse impacts of the price volatility of fossil fuels.[75] Additionally, electricity demand is projected to grow by 0.8 percent per year in the US through 2035, indicating that additional generating capacity will be needed, although not at the scale of most emerging markets.[76] In order to increase their energy security by meeting rising demand and mitigating the use of fossil fuels, North American countries are taking steps to increase their production of renewable energy resources, including geothermal.

In the US, federal and state policies have been the drivers for renewable generation. At the federal level, since 2005 geothermal and all other renewable technologies have been afforded important tax incentives to attract investors. At the state level, most have adopted renewable production requirements for their electric utilities. Recently, uncertainty has grown about whether Congress will continue to extend federal renewable power incentives and the economic recession has dampened state renewable effort. Yet, growth continued in 2011 and additional growth in geothermal power capacity is projected for the next two years.[77]

United States

The development of geothermal energy resources for utility-scale electricity production in the United States began in the 1960's. Since that time, the continual development of geothermal resources and technology has positioned the US as a leader in the global geothermal industry. The US currently has approximately 3,187 MW of installed geothermal capacity, more than any other country in the world.

Figure 4: Annual US Installed Capacity Growth 2008-2012



Source: GEA

As indicated by Figure 4, geothermal companies continue to increase the development of geothermal resources in the US. In 2010 geothermal energy accounted for 3 percent of renewable energy-based electricity consumption in the United States.[78] While the majority of geothermal installed capacity in the US is concentrated in California and Nevada, geothermal power plants are also operating in Alaska, Hawaii, Idaho, Oregon, Utah, and Wyoming. Five additional geothermal projects with gross capacity of approximately 91 MW came on line in 2011 and early 2012.

Table 2: Geothermal Development Completed in 2011 and Q1 2012

Name	Company	State	Project Type*	Year Completed	Capacity (MW)
Puna Expansion	Ormat Technologies	HI	CH Expansion	2011	8
Beowawe 2	Terra-Gen	NV	CH Expansion	2011	1.9
Hudson Ranch 1	Energy Source	CA	CH Unproduced	2012	49.9
Tuscarora	Ormat Technologies	NV	CH Unproduced	2012	18
San Emidio	U.S. Geothermal	NV	CH Expansion	2012	12.75
Total:					**90.55**

***For an explanation of "project type" terms please see GEA's 2012 Annual US Geothermal Power Production and Development Report**
Source: GEA

In total, 3,187 MW of geothermal power was on-line as of April 2012. These power plants were located in nine states: California, Nevada, Hawaii, Utah, Idaho, Alaska, Oregon and Wyoming. This represents an increase, net, of 77MW.

Additional geothermal resources are under development in the US. As of April 2012, there were 147 projects identified under development, with over 5,000 MW of power potential. These projects were found in over 15 states, comprising over one-third of the land area of the United States.

Table 3: Total Projects in Development Totals by State

State	Total Projects	Overall Total (MW)
Alaska	6	90
Arizona	1	2
California	31	1859.7-2008.7
Colorado	2	20-25
Hawaii	3	0
Idaho	11	589-664
Louisiana	1	0.05
Nevada	59	2030.15-2250.15
New Mexico	2	115
North Dakota	1	0.25
Oregon	16	319.5-364.5
Texas	1	0.8
Utah	11	190-215
Washington	1	100
Wyoming	1	0.28
Total	**147**	**5317-5836**

Source: GEA

Canada

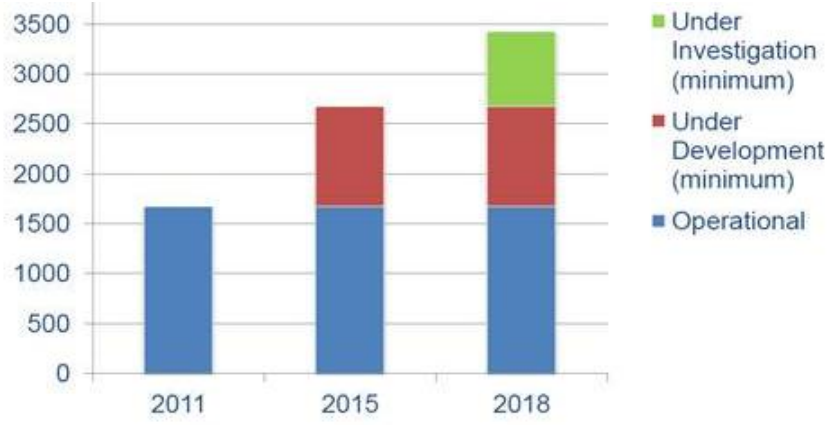
Although it lacks any operating geothermal power plant capacity, Canada has geothermal potential. In 2011 the Geologic Survey of Canada released an assessment of the country's geothermal resources, finding that the geothermal resource potential in Canada was large enough to replace approximately 10 nuclear power plants and provide up to 10 percent of the country's electricity generation. The Canadian Geothermal Energy Association (CanGEA) estimated that Canada's geothermal potential represented a nearly US$ 25 billion market opportunity for companies interested in developing the country's geothermal resources.[79]

A handful of private companies have taken an interest in Canada's geothermal resources and are engaged in development there. Borealis GeoPower is currently developing a geothermal resource at Fort Laird in the Northwest Territory for both power production as well as the direct heating of the community. The project has been approved for US$ 10-20 million of funding from Canada's Natural Resources Clean Energy Fund. Borealis GeoPower has also acted a third party consultant to DEEP Earth Energy Production in the development of the latter's Rafferty project in Saskatchewan where initial exploration drilling is expected to commence in 2012.

Europe

Significant geothermal energy capacity is now being developed across Europe. As of 2011, Europe had a total installed capacity of 1,600 MW for geothermal energy, producing 10,900,000 MWh of electric power through 59 geothermal power plants, 47 of which were in European Union (EU) member states.[80] Europe currently has 109 new power plants under construction or under investigation in EU member states.[81] By 2015, Europe is expected to have about 1,600 MW of installed geothermal energy capacity, with an additional 1,800 MW to be under development or investigation by 2018.[82]

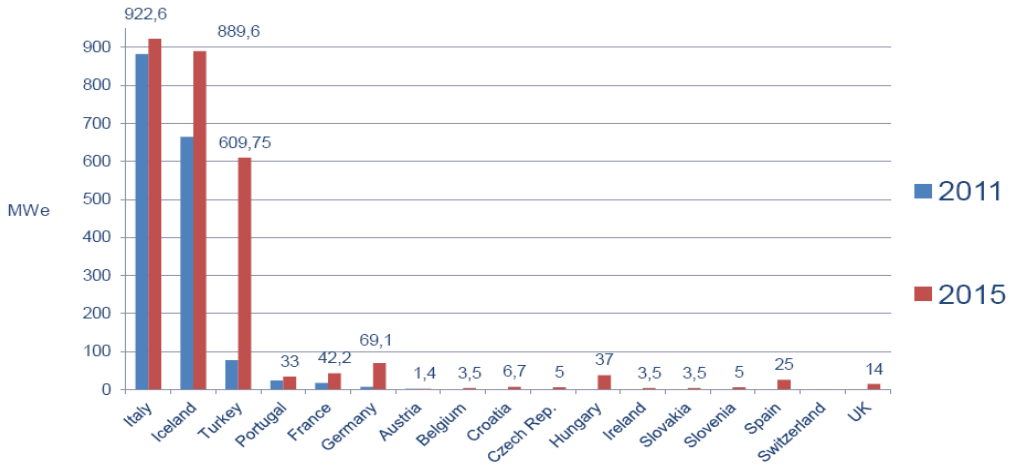
Figure 5: Installed Capacity of Geothermal Electricity in Europe (MWe)



Source: EGEC

Within Europe, Italy is the market leader with over 50 percent of the European capacity (see Figure6).[83] Turkey and Iceland are currently centers of geothermal exploration and development in Europe and Germany is considered a new, but important, player in the market.[84] Geothermal development is also taking place in Portugal, Spain and France.[85] Although enhanced geothermal systems (EGS) geothermal plants are not yet considered economically viable, Europe has 11 EGS projects under development in Croatia, France, Germany, Hungary, Ireland, United Kingdom, Slovakia, Slovenia, and Spain.[86]

Figure 6: Installed Capacity per Country and looking to the next three years



Source: EGEC

Despite the advancement of geothermal technologies, development is proceeding at a slower pace than for other renewables, mostly due to the lack of support schemes. For example, twenty-three EU member states have feed-in tariffs in place for renewable technologies, [87] but only ten of those provide feed-in tariffs for geothermal.[88]

Considering EU's climate change efforts and its goal to reduce greenhouse gases by 20 percent, or even 30 percent, by 2020 from 1990 levels, electricity from geothermal sources has a "huge potential" to help reduce emissions, according to calculations by the IPCC.[89]

Germany

In 2010 and 2011 Germany generated around 628 and 615 billion KWh of electricity, respectively. Germany's largest source of electricity is coal, which makes up almost 25 percent of overall production. In 2010 the second largest source of power was nuclear with 22.4 percent, while in 2011 renewable sources came in second with 19.9 percent, whithin which geothermal energy was not yet a significant factor[90] with only 19,000 MWh.[91] Nevertheless, as the German geothermal energy association shows, deep-drilling geothermal energy (which includes power and heat) generated 1,400 jobs in 2011.[92] Germany's goal for power production from renewable energy is 30 percent by 2020.[93] Despite Germany's declining population, energy consumption is projected to increase due to an growing number of individual households and mobility requirements.[94]

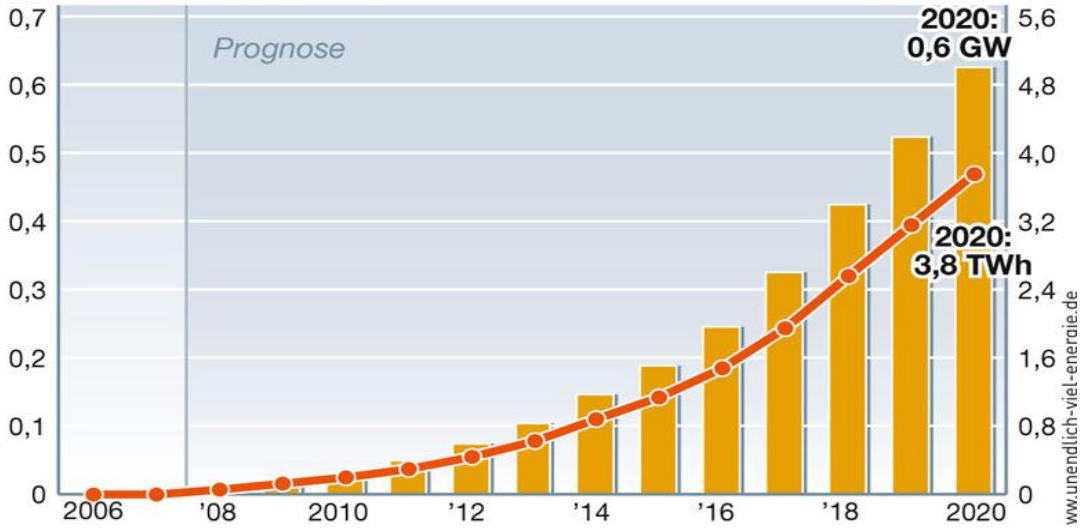
In 2010 Germany generated 27,700 MWh from geothermal energy,[95] supplying power for over 9,000 households. The following year Germany only produced 19,000 MWh[96] for two reasons: the two largest geothermal plants in Germany underwent substantial maintenance, and one of them, in Unterhaching, switched from power to increased heat generation due to higher demand for heat.[97] Germany currently has an installed capacity of 7.3 MW for electricity generation from five geothermal power plants.[98] Another 68 geothermal plants are being planned for development in Germany, 22 of which are designated for power generations. For the remaining 42 plants in the planning stage it is not clear yet whether they will be used for power generation or district heating.[99]

Figure 7: Areas with Geothermal Potential in Germany

Source: Geothermie-Dialog

Germany has three regions, located in the far north and in the south of the country, well suited for geothermal electricity generation as shown in Figure 7.[100] The German Renewable Energy Association estimates that 600 MW of geothermal energy for will be installed for electricity generation in Germany by 2020.[101] There may be even more geothermal potential in Germany. The country's Ministry for Environment and Nuclear Safety estimates that Germany has 15,000 MW of geothermal potential for electricity generation, both through improved technologies and through new sites projected to be in the north of the country.[102]

Figure 8: Potential Geothermal Growth in Germany Through 2020



Source: Geothermie-Dialog

Germany has been increasing its support for geothermal energy, especially at the front end of geothermal projects in order to reduce investors' risk related to the initial exploration. The German Environment Ministry and two German banks are supporting deep-drilling projects with overall € 60 million (around US$ 77 million).[103] A geothermal drilling project in Germany can often cost over € 10 million.[104]

Further to Germany's 2004 Renewable Energy Sources Act, a new amendment in 2011increased the geothermal feed-in tariff from 25 Euro cents/KWh to 30 Euro cents/KWh.[105] Although an earlier amendment of the Act reduced bonuses and other incentives for power plants going online, the 2011 amendment postponed the reduction for geothermal energy to the year 2018. Maintaining the bonuses until 2018 is meant to speed up geothermal R&D and technology development.[106] Overall, the 2011 decisions increase compensations for wind and geothermal energy in comparison to the Act's 2009 amendment.[107]

Germany's largest geothermal plant, located in Bavaria, and with a capacity of 38 MW power and heat, was developed with public aid.[108] So far all geothermal deep-drilling projects in the state of Bavaria have been developed with public aid from municipalities. One current project in Aying, Bavaria (estimated to cost € 35.6 million, or around US$ 46 million) is to be the first geothermal power plant to be developed with private financing only.[109] The plant is planned to generate 46,000 MWh of electricity for about 18,000 households, and is expected to come online this year.[110]

Turkey

Turkey forecasts 6-8 percent annual growth in energy demand until 2020, expecting to add 50,000 MW to the grid.[111] Deemed to be one of the "hottest" markets in Europe for geothermal, Turkey is the seventh most promising country in the world in geothermal energy potential.[112] Currently, Turkey has approximately 100 MW of installed capacity for geothermal power generation.[113] The proven geothermal capacity for electricity generation in Turkey is around 800 MW.[114] The Turkey Geothermal Association estimates that there will 550 MW of installed geothermal capacity in Turkey by 2015, up from the current level of around 100 MW, while others say it will be closer to 600 MW.[115] Attaining the goal of 550 MW of installed capacity by 2015 is estimated to require an investment of around US$ 1.6 billion. The country had 17 companies developing 484 MW of additional capacity from the estimated 2,000 MW of geothermal power potential.[116] Enel Green Power has recently focused on developing Turkey's geothermal potential[117], and obtained a package of 142 exploration permits in western Turkey.[118] TAS, another company deeply involved in geothermal energy, has just opened a new office in Turkey where it will give "particular emphasis" to the geothermal power generation segment[119].

Building on plans to launch about 120 energy investment projects by 2020 with the focus on geothermal energy projects,[120] Turkey's Energy Ministry stated in 2011 that the country could save up to US$ 400 million annually and provide jobs to up to 300,000 people by fully taking advantage of its geothermal energy potential.[121]

Early 2011 the Turkish parliament adopted a new 10-year feed-in tariff policy, with tariffs for geothermal being lower than those for solar and biomass, but higher than the tariffs for wind energy and hydro power. In addition, the parliament added a bonus for components "made in Turkey".[122] Still, Turkey continues to enlist the goods and services of foreign companies in the development of their geothermal resources. Recently, the Commercial Service at the US Embassy in Turkey reported that it had received five to seven inquiries per month for potential US suppliers of renewable energy and energy efficiency equipment, services and technology.[123]

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