Geothermal energy: the pool of jobs!!

Lynn Manijean and Pascal Saffache

Keywords

geothermal potential, job creation, skilled gap, workers deficit, training

ABSTRACT

Climate change is a threat to humanity. Some scientists agree that global warming is linked to human activity, others disprove its existence. However, proof of such evidence are not lacking, sea-level rise, melting of ice caps, the increase in temperatures, the increase in the number of devastating hurricanes, flooding, and others effects. Faced with such scourge, governments are putting forth efforts to fight against the consequences of global warming. Thus, at the various international conferences on climate, commitments have been taken between developed countries and developing countries in favor of the climate in order to counteract the effects of global warming. Among the measures taken by the governments are to reduce greenhouse gas emissions and lessening their dependence on fossil fuels (oil, coal, natural gas) in the coming years. To do so, they have decided to turn to renewable energies, which are playing a key role in the energy transition. In this respect, geothermal energy can be one of the alternative solutions against global warming. Since geothermal has been discovered as a renewable energy source, projects all over the world have begun flourishing. The development of such projects has made it possible to create long-and short-term so-called green jobs. Indeed, the geothermal sector is a vector of employment both locally and internationally. Although it has significant potential, the geothermal industry is experiencing a shortage of workers and skills that must be solved in order for geothermal energy to be better known and facilitate its development for greater use. By using geothermal energy, one can generate reliable around the clock electricity as compared to solar, wind and hydro. This article will present a brief discussion on what is geothermal energy, especially its historical aspect. Then, we'll discuss about job opportunities in countries that can be generated when engaged in developing geothermal projects and finally what can be done to reduce the skills gaps.

1. Introduction

The earth is storing a huge among of heat called geothermal energy. It is a clean and reliable renewable energy resource that offers many advantages, compared to even the other renewable

sources of energy. Compared to fossil energy geothermal energy emits much less carbon dioxide. The word geothermal derives from the Greek word “geo” (earth) and “therm” (heat). The heat stocked beneath layers of molten rock is generated by the disintegration of radioactive elements of uranium, thorium, and potassium present in Earth’s crust and mantle. The heat emitted by fission varies with the chemical composition of the rocks (Ademe /Brgm, 2004) and flow to the surface (Figure 1). Thus, the temperature located inside of the earth center varies, depending on the zone explored. The deeper into the earth the hotter the temperature will be due to an increasing temperature gradient.

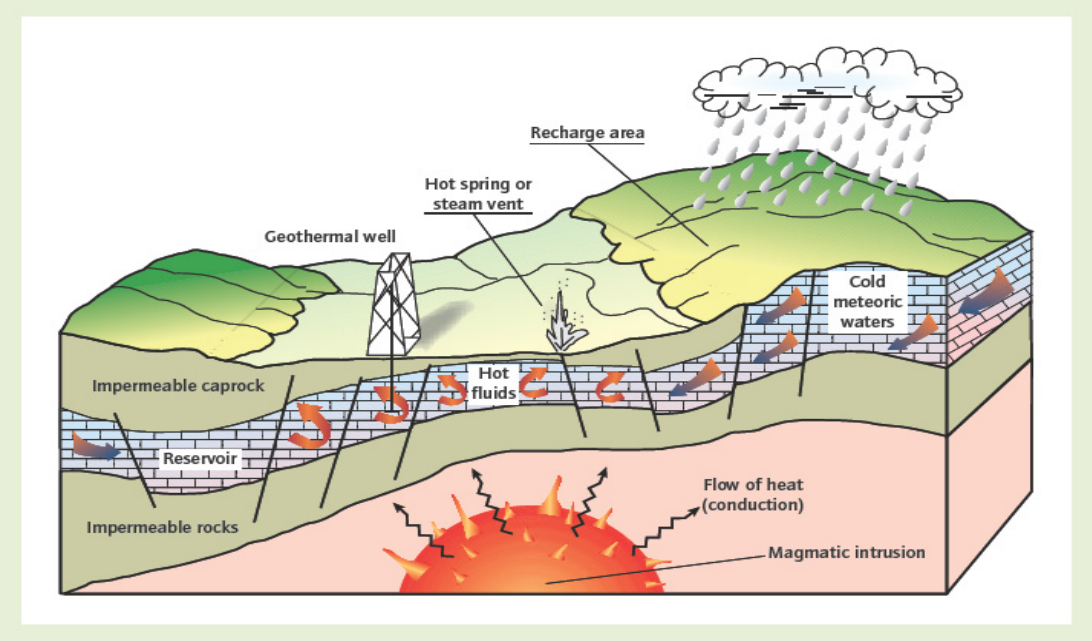

Figure 1 Schematic representation of a typical geothermal system (source: Credo Reference)

Contrary to the other forms of renewable energy, such as solar, wind, and hydro, geothermal energy is not dependent on ephemeral climatic conditions but depends only on the intrinsic characteristics of the subsoil, (geothermal gradient, characteristics of rocks, circulation of fluids, etc.; Ademe /Brgm, 2004).

Furthermore, geothermal energy owes its classification as renewable energy due to the fact that the water contained in the reservoir is continually reheated as the heat is continually produced from the rock. As a matter of fact, when rainwater or snows melt flows into the underground reservoir, in other words the hot aquifer, it is heated by the hot rocks and trapped in the cracks or pore spaces of the capped hot rocks that form the geothermal reservoir (Figure 2). Thus, we can say that geothermal resources will never run out because they are a sustainable continuous process. However, we have an example of geothermal resource that has dried out that of the Geysers, in California, the exhaustion of geothermal resource can be overexploitation of the resource, in order word extracting more heat than what is contain in the reservoir or not recharged with the fluid extracted, hence the need to reinjection the fluid into the reservoir. The

energy is in the hot water, so the water stored in the reservoir is extracted from a production well. Once the hot water arrives at the surface by means of a pump or artesian flow, a flash vessel separates the steam from the water to turn a turbine, or, in the case of a binary power plant, the heat is exchanged to a secondary fluid which vaporizes and turns the turbine instead of steam. This steam (or secondary fluid) is used to produce electricity. The now cooler water is directed to the reinjection well where it is pumped back into the geothermal reservoir to be reheated. This procedure avoids waste and instead helps the geothermal reservoir to continue producing hot water or steam and is, thus, renewable.

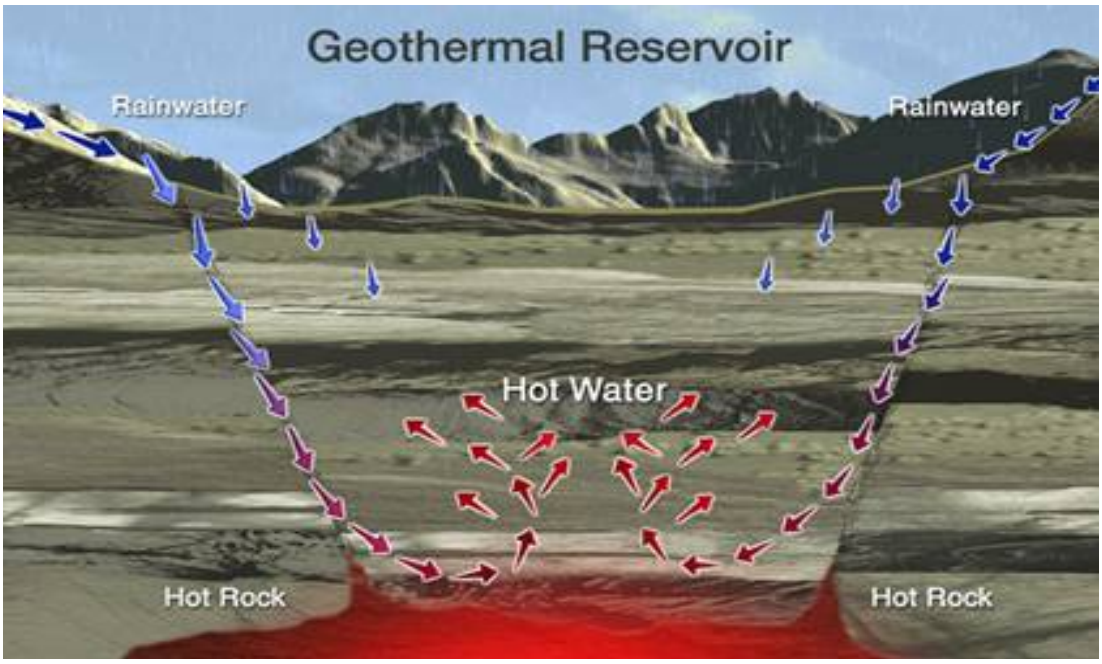

Figure 2: The Formation of a Geothermal Reservoir
(Source: Geothermal Energy Association, geo-energy.org)

Geothermal energy is the oldest natural energy resource. In Roman times and other civilizations, geothermal resources were used for house heating, washing clothes, cooking, agriculture, beauty treatments, hot baths and therapeutic benefits. For example, the Indians of the Americas considered hot springs as a sacred place where the "Great Spirit" lived, and thus were great believers in the miraculous healing powers of the heat and mineral waters (Lund, John W, 1995). All geothermal features (fumaroles, hot springs, geysers) were held sacred by the Native Americans because of their deep respect for nature and because it always provided for their daily needs. They use nature not only to sustain them but to heal themselves and observe rituals. However, in the 20^{th} century a better understanding of the earth and technical progress has allowed man to exploit the heat contained in the center of the earth, allowing man to generate electricity from this underground heat source.

Geothermal energy is a clean sustainable energy resource that emits little carbon dioxide (CO_2). It is always available and consumable at its place of exploration. Although present everywhere, thermal heat varies from one area to another, depending on the structure of the geological formations and the composition of the rocks. This energy will be more or less easy to extract (Ademe /Brgm, 2004), the development of a geothermal project requires a fairly substantial investment, starting with the exploration phase. However, the cost of investment during the operating phase will be low because the fuel supply has been developed. As a comparison, geothermal energy is more competitive than fossil fuels and generates more reliable electricity. The raw material (steam or hot water) does not fluctuate due to weather conditions associated with other renewable resources.

2. Geothermal history

The 19th century marked the development of geothermal energy as an electricity resource. In 1818 in the region of Volterra (Italy), François Landerel endeavored to exploit geothermal energy by inventing the "open lagoon" which consisted of extracting steam at a sufficient temperature, to supply machines intended to pump the boric waters(Ademe /Brgm, 2004; Figure 3).

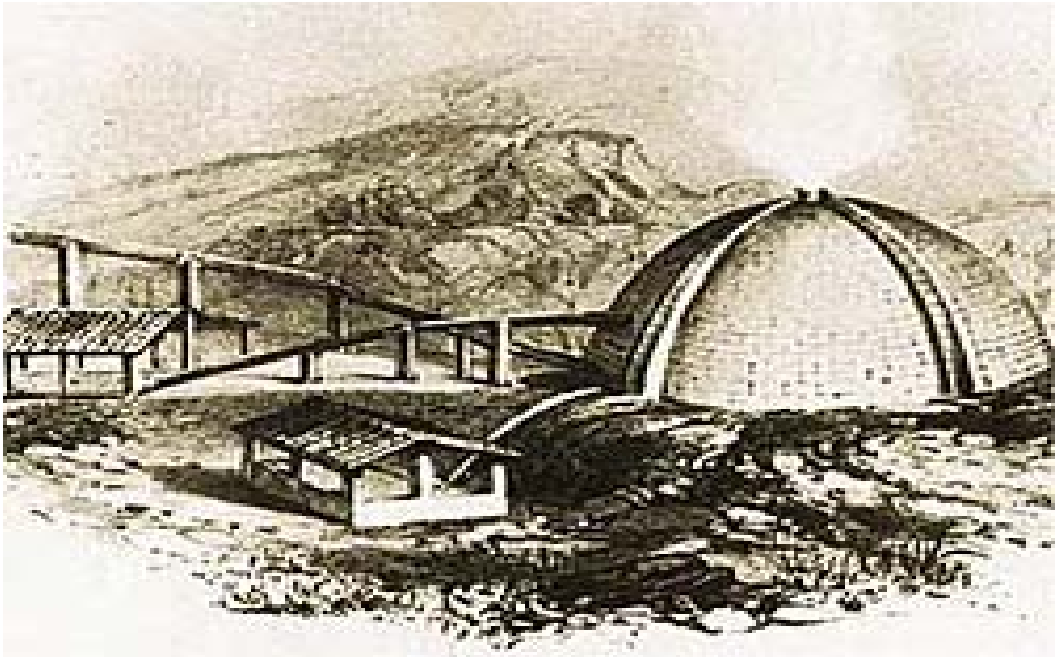

Figure 3: The "covered lagoon" technique allows the steam to be collected and discharged at a sufficient pressure to feed the evaporating boilers and pump the boric water. (Source: BRGM/ADEME, Géothermie-perspectives).

In 1904 in Landerello Italy, Prince Ginori Conti initiated the production of electricity from geothermal energy by building the first 20 kW experimental power station (Figure 4).

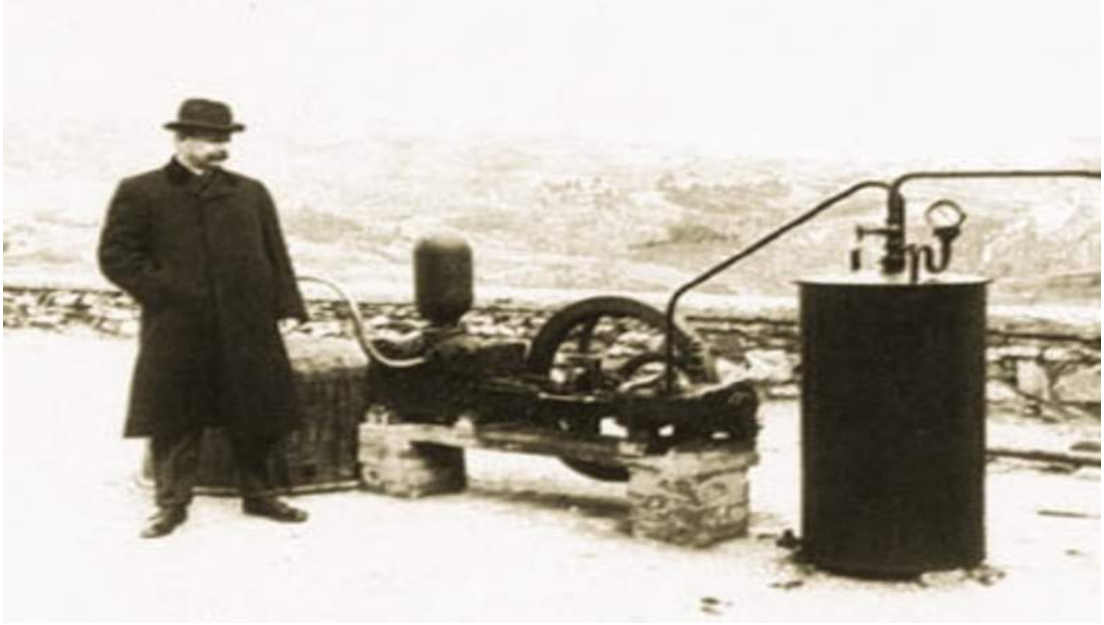

Figure 4: The engine used at Larderello in 1904 in the first experiment to generate electricity from geothermal steam alongside its inventor, Prince PieroGinori Conti. (Source: International Geothermal Association)

In 1913 the first commercial power plant went into operation in Italy. Nevertheless, the method of geothermal exploitation launched by François Landerel was improved. Today, geothermal power plants can be found all around the world (Figure 5).

Figure 5: geothermal power plants around the world (source: lifefreeenergy.com)

Although the United States is leading in electrical generation capacity, Iceland remains the country where geothermal energy is omnipresent and is largely use for heating. Today, there are over 350 high and medium-energy geothermal installations in the world (Ademe /Brgm, 2004), yet still there is much to be achieved. Despite its slow growth, geothermal offers great benefits by economically helping a country to reduce its dependence on fossil fuel and contributing to a lower the cost of electricity if that country has a more expensive energy supply such as diesel fuel. Furthermore, it can work for the preservation of the environment and above all it offers great job opportunities.

3. Job opportunities

In recent years, the geothermal industry has generated a great number of jobs, and will keep increasing due to the concerns about climate change and the need for more renewable energy. Furthermore, the development of geothermal energy on the one hand has generated direct employment linked to the construction and maintenance of the power plants and on the other hand indirect jobs offering goods and services to the companies engaged in a geothermal project. Moreover, when a company is involved in such a project it calls on subcontractors who represent a large part of the construction workforce. Indirect jobs refer to government regulators, lawyers, architects, equipment service personnel, geologists, business management personnel, security guards, and others.

However, when developing a geothermal project, skillful preparation is needed including the location of the drilling sites and an assessment of both workers and material will be evaluated. Indeed, working in the geothermal field involves different specialties; however, we cannot really quantify the number of workers hired in a geothermal project because it varies depending on the size of the power plant that will be built and the number of wells needed. In general, the bigger the project is the more workers that will be needed. Yet, at each stage of a geothermal project, people with different skills, experience and education level is necessary (Table 1).

As mentioned previously, the evaluation of a geothermal project requires careful preparation. Before starting the exploration of a site, professionals from various trades, such as geologists, engineers, environmental consultants, biologists, hydrologists and archaeologists, will meet to discuss about different actions that need to be taken and their potential impact. First, a field survey will be carried out to determine the type of soil and is it possible that excavations could discover historical artifacts. In addition, studies of existing research will help assess the environmental risks that may arise from a proposed project. Thus, this will allow designing measures to minimize environmental effects and to provide protection of the environment. However, in order for this work to take place the various partners of the project must obtain governmental authorization, hence the presence of lawyers. Once the authorizations have been acquired and the field studies undertaken, the exploration phase can begin.

During the exploration phase, the geothermal field will be evaluated so as to plan the drilling work for production and injection well locations. As a result, geologists, geophysicists, geochemists, engineers and specialists in geographic information systems will be mobilized. The data collected will be analyzed for the drilling phase. During this phase, experienced staff will be required (Table 2) including security managers, site managers, administrative and management teams, who lead and support operations. Once the drilling is completed and the well test data has been analyzed, the moment to discuss the design and construction of the plant arrives with the

aim to determine the size of the power plant which will determine the duration of the geothermal power plant construction. This phase requires a significant number of workers, according to the size of the plant (Table 3). To build a geothermal power plant, a large number of different equipment must be manufactured. This equipment will be made separately and be linked together at the power plant site. As soon as the plant is finished, the operation and maintenance phase begins and permanent jobs are created. The number of people hired will be less than in previous stages and will be different from previous occupations. It is a function of the size of the plant and well field.

Table 1: Job Types throughout the Project Development and Operation

Start-up	Exploration	Feasibility drilling	Drilling and construction	O&M
•Geologists •Biologists •Hydrologists •Archeologists •Lawyers •Paralegals •Environmental Engineers	•Geologists •Geophysicists •Geochemists •Engineers •GIS specialists •Exploration drillers •Sample analysts •Consultants	•Drilling engineers •Rig hands •Mud loggers •Drilling fluids personnel •Cementing personnel •Casing crews •Directional drillers •Rig transportation •Fuel transportation •Welders •Safety Managers •Geologists •Construction personnel	•Engineers •Power plant designers •Document controllers •Project managers •Construction managers •Project engineers •Field engineers •Safety managers •Welders •Steel erectors •Concrete placers •Assembly mechanics •Inspection Personnel	•Plant managers •Engineers •Plant technicians •Site operators •Service repairmen

Source: GEOELEC

Table 2: Jobs Involved in Geothermal Development (50 MW)

Stage of Development	No. of jobs
Start-up	10 – 13
Exploration	11 – 22
Drilling	91 – 116
Plant Design and Construction (EPC)	383 – 489
Operation and Maintenance	10 – 25
Power Plant System Manufacturing	192 – 197
Total	**697 – 862**

Source: GEOELEC

For example, a 50 MW power plant will have approximately 860 different workers, (Jenne john, 2010) from all different stages of a geothermal power plant development, from project design to the operation and maintenance of the plant. The United States is the world's leader in installed geothermal capacity, even ahead of the Philippines. The largest geothermal resource in the US and the world is in California. The Geysers geothermal complex is made up of 21 power stations and more than 350 wells. However, to manage this huge geothermal complex, it was necessary to employ a significant number of workers, 425 full-time and 225 part-time employees from the local community, who were employed by the company (GEA, 2014). The state of Oregon is known for been using geothermal energy for many years, it has always been one of the leading states of geothermal energy consumption. Several geothermal projects have emerged in different parts of Oregon, and have allowed the creation of more than 300 jobs geothermal energy has been estimated to have created more than 300 jobs (Grainey, M.W, 2014).

However, despite the efforts that have been done by countries that are engaged in geothermal energy, recruiting competent and skillful workers remains a challenge. Yes, geothermal energy offers a large range of jobs, employs highly skilled workers capable of realizing the different tasks and duties entrusted to them; however, this sector is faced with a skilled worker shortage, which is one of the issues highlighted by the KnowRES report (April 2016). The KnowRES report was initiated by the European Union, in collaboration with the Association of European Renewable Energy Research Centres (EUREC), "which provides information on recruitment trends, forecasts and most wanted profiles including key competences […] identifying the profiles that companies are looking for, […] it also highlights the expertise and competences that are lacking and/or need to be further developed" (Xu, 2014). A survey was completed on an entire geothermal project that is from the preliminary study to the exploitation and maintenance phase. It emerged from this survey that the field of activities concerned with a lack of skilled professionals are: drilling engineer (supervisor), project manager and plant manager, Operation and Maintenance manager.

The companies engaged in this survey highlighted the difficulties they encountered during recruitment. They are confronted with people whose training is not appropriate to the trade or who do not have enough of work experience. Additionally, they are confronted with a lack of candidates for job vacancies, particularly for the drilling phase, where drilling techniques specific to this geothermal are needed. Potential candidates, who can compensate for this shortage of experienced candidates in drilling, are those from the oil and gas sector. Indeed, in order to extract the oil from its reservoir the only method used is drilling. The workforce on the oil and gas platform has received appropriate training in the oil industry where drilling techniques and other skills were taught. Consequently, this workforce in the oil and gas sector has all the experience and skills needed to work in the geothermal sector; this is called a transfer of skills or transferability of skills from one sector to another sector. As a matter of fact, companies in the geothermal industry can hire workforce from the oil and gas sector to replace retiring workers of the geothermal field. However, appropriate training will be provided to them. By proceeding to a transfer of skill, it can help to reduce the shortage of skills in the geothermal sector

Since geothermal energy was first developed and countries have been utilizing this energy to generate electricity, methods of exploitation have evolved, and new equipment and machinery have been developed in order to be more efficient. Therefore, skill gaps can be created "that

education and training in many cases cannot follow […] that employers have no incentive to educate young people since after the training they may shift to another company or sector"(Schützet al., 2013).Besides, the lack of skills and professional experience that those companies are looking for the geothermal energy sector requires flexibility. A person committed to this field has to adapt himself to changing environment, traveling that may be required to accomplish the task, and to the long mission he will have to perform. These working conditions and the skills required can be a source of discouragement for a person who might be interesting in geothermal energy. Apart from the specialties listed above (Table2), other phases of a geothermal energy project require skilled workers, although some of these phases do not need that many workers.

3. What Can Be Done?

Geothermal energy is a booming industry. However, the lack of professional skills and a misunderstanding of this resource hinder the development of geothermal energy. To overcome this lack of visibility and knowledge deficit, concrete and practical measures need to be put in place, or those in place, require more commitment from both sides. To make known the benefits, potential and uses of geothermal energy, it is important to inform the public, partners and public authorities, by using the various means of communication available. For example, organizing geothermal awareness days and conferences are effective tools for public communication and education. Furthermore, the implementation of training programs at universities offers to student to the necessary skills required in the geothermal sector. Moreover, in order to make the geothermal sector more attractive, it would be useful to initiate young people. The aim of this initiative is to act at all levels of the educational system, namely: technical and scientific education, apprenticeships and continuing education (European Geothermal Energy Council). This initiation would go through a work-study program to enable the acquisition of skills and knowledge of the sector. To achieve this, collaboration between enterprises, institutions, employment agencies and the educational community is necessary. This cooperation will help to ensure a frequent updating of the content of educational and training programs, so that the skills and knowledge of graduates are always updated (Schütz et al., 2013). Apprenticeship and internships contribute to the development of appropriate skills. These will allow the apprentices to discover the labor market while acquiring professional qualifications. The knowledge and skills acquired will be essential for a better understanding of the job. Hiring apprentices will be beneficial for the company and the knowledge and skills acquired by the apprentice will be useful for the geothermal industry. In addition, it is important to ensure the preservation of knowledge and skills achieved in the past because the more experienced employees can share their years of experience with the newer ones. The geothermal industry can improve its image by making it more attractive to new employees, by informing them about the many opportunities offered to them such as working conditions, better salaries, to deepen their skills and competences by learning new things, and raising awareness about the benefits of working in this industry, improving the provision of information on career opportunities ((Schütz et al., 2013)˙. The companies, governments and other organizations can contribute to the acquiring of professional qualifications, by supporting financially universities, polytechnic schools, training organizations, implementing educational and training programs, so that skills, experiences, knowledge can be achieved by apprentices and by those attracted by geothermal energy. Those who have been in the profession for many years can benefit from this program by upgrading their skills too. In the coming years, we expect an increase of employment in the geothermal energy

industry. However, through our research, we have seen a lack of professional competence, as well as a lack of knowledge of the resource. In order to ensure that the gaps and shortages of labor do not persist, it is important to take measures to fill the gap in professional skills; and to reduce the gap between skills and the shortage of qualify labor.

4. Conclusion

Since its discovery, geothermal energy has found its place within the energy mix. This clean, sustainable energy, offers an excellent environmental, economic, and social perspective. Indeed, geothermal energy is a tool to fight against global warming because it is renewable and less polluting than the other resources. From an economic point of view, it could contribute economic development and at the same time to job creation. However, although our planet has an undeniably unexploited geothermal potential, it has enabled the countries involved in this sector to create permanent jobs. Nevertheless, this sector suffers from a lack of skilled labor, which hinders its expansion, despite the arrangements that have been put in place, such as the conferences and the professional training.

Over the next few years the number of jobs in the geothermal sector will increase due to the increase in geothermal power plants that will require skilled labor and professional skills. Thus, it will be necessary to inform the public about the geothermal potential that this resource represents and the advantages of exploiting it. Today, geothermal energy is booming and it could be the energy of the future if certain parameters are improved and made known to the world.

References

ADEME /BRGM. “Principes de fonctionnement et usages de la géothermie ". *Syndicat des énergies renouvelables,* juin 2012.

Battocletti, L and Lawrence, B& Associates, Inc. “The Economic, Environmental, and Social Benefits of Geothermal Use in Hawaii”, June 2006.

Chiasson, A.“The Economic, Environmental, and Social Benefits of Geothermal Use in the Eastern United States”.*Geo-Heat Center Oregon Institute of Technology*, June 2011.

Chiasson, A.“The Economic, Environmental, and Social Benefits of Geothermal Use in Oregon”.*Geo-Heat Center Oregon Institute of Technology*, October 2011.

Collectif BRGM-ADEME.“La géothermie : quelles technologies pour quels usages ?” .Edition BRGM. 2004, p 6-7.

European Geothermal Energy Council. “Fiche d’information sur électricitégéothermique”.Geoelec.

Geoelec, *Emploi et Formation*, 2013.

Geothermal Energy Association. “*Geothermal Basics: Employment”*.

Grainey, M.W. “Geothermal Energy in Oregon: Job Creation and Other Benefits from New Geothermal technologies”, *GRC Transactions*, Vol. 38, USA, 2014.

Jennejohn, D. “Green Jobs through Geothermal Energy”,*Geothermal Energy Association*, USA, October 2010.

Madet, D. “ Hydraulique et géothermie : principes physiques et modalités d’utilisation”, E2PHY, 27Août 2001.

Matek, B and Gawell,*K*. “The Economic Costs and Benefits of Geothermal Power”, *Geothermal Energy Association*, USA, June 2014.

Mburu, M. “Geothermal Energy Utilization”, Lake Naivasha, Kenya, November 1-22, 2009.

Lund, J.W. “Historical Impacts of Geothermal Resources on the people of North America”.*Research Associate Geo-Heat Center*, GHC Bulletin, October 1995.

Omer, A. “Environmental and socio-economic aspects of possible development in renewable energy use”, January2010.

Riley, L. “The Economic, Environmental, and Social Benefits of Geothermal Use in Washington State”. *Geo-Heat Center Oregon Institute of Technology*, December 2010.

Schütz, F., Huenges, E., Spalek, A., Bruhn, D., Pérez, P and De Gregorio, M.“Employment study: solutions on lack of skilled workers in the geothermal sector & results of the questionnaires”.Geoelec, Deliverable n° 5.1, September 2013.

Xu, L. “The Geothermal sector report”, KnowRES, April 2016.