GEOTHERMAL DEVELOPMENT IN PERU: OPPORTUNITIES, CONCEPTS, ACTIONS, RESULTS AND RECOMMENDATIONS

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"*Use of geothermal energy for power generation is underdeveloped and its potential is greatly underappreciated. It is climate independent, produces minimal or near-zero greenhouse gas emissions, does not consume water, and its availability is infinite at human time scales*."

United Nations World Water Assessment Programme (WWAP, 2014).

It's not a purely economic decision to embark on increasing the percentage of renewable energy ……it is also a "social decision" particularly balancing affordability and sustainability dimensions.

Randy Zwirn President and CEO Siemens Energy, Inc. on US geothermal development at the MIT Energy Conference Feb 21, 2014 (The Energy Collective, March 2014.

ABSTRACT

Peru is among the fastest growing economies in Latin America, with a steadily growing energy demand. Energy supply has been historically met by hydro and natural gas-fired plants, which constitute a poorly diversified power matrix, and are showing several issues for its management and expansion of generation capacity. Geothermal offers a unique opportunity to integrate an autochthonous, clean, renewable and base-load power source to the energy mix. The Peruvian territory is endowed with significant and strategically located geothermal resources, whose potential for power generation is estimated in nearly 3,000 MWe. Peru is also one of the few South American countries that has a geothermal law and regulation to promote private participation. Several geothermal companies got involved in geothermal exploration in Peru since 2010, and the Peruvian government, with technical and financial support from the Japanese Cooperation Agency (JICA), issued in 2012 a national Geothermal Master Plan aimed at fostering the implementation of a geothermal industry in the country. However, despite all the potential and interest, the Peruvian geothermal option is still struggling to succeed and no power generation from geothermal sources has been achieved so far. A complex set of problems and issues have been constraining the geothermal development in Peru, being the main components related with the geothermal and social context knowledge, the political and policy framework, the regulatory framework, and the infrastructure and implementation support. Lack of articulation among those components, and eventually among the key stakeholders (Government-Communities-Geothermal Companies) has been particularly identified as one of the key obstacles for action.

An interesting reactive process started to occur in 2010 when private companies involved in geothermal exploration faced and analyzed this situation. By then authorities at the regional and local level, and the inhabitants of the prospective geothermal areas had not been informed about geothermal or prepared for the administrative process. Geothermal companies met opposition from local communities in several geothermal areas, therefore they recognized the need of joining efforts, and progressively organized creating a Peruvian Geothermal Association (APG). Applying many of the concepts presented in this document, national institutions like INGEMMET and MEM-DGE were invited to work in coordinated fashion to effectively establish communication and articulation among communities, government and geothermal companies.

Coordination meetings with institutions and organisms eventually led to the deployment of itinerant workshops where representatives from the communities, the geothermal companies, and the national, regional and local levels of government, met to learn and discuss geothermal development and the possible actions for making it successful. Articulation with environmental institutions and organizations was focused on issues associated with coexistence of protected areas and geothermal development, with particular reference to the Vilacota-Maure Regional Conservation Zone, that contains some of the most prospective geothermal resources of Peru. Geothermal applications within the conservation zone and its buffer fringe were being denied due to environmental regulation constraints. Joint work between companies and institutions was also performed on reviewing the geothermal regulations. Legal teams from geothermal companies shared and exchanged expert opinions with MEM's legal advisors. Several meetings were held by geothermal companies, organized as APG, with authorities from different sectors and levels of government, seeking support for revision of certain unclear aspects of the regulations.

The effort paid off. Through this articulation/communication approach, communities that initially rejected the possibility of geothermal development now welcome the geothermal initiative. The compatibility between geothermal and the Vilacota-Maure conservation zone has been successfully discussed at all appropriate levels, contributing to clarify the process of obtaining environmental instruments that will allow exploration and, eventually geothermal development, in natural reserve zones. The review of the geothermal regulations had a first key result with the issuance of the Supreme Decree No. 015-2013-EM that removed inconsistencies between granted exploration periods and environmental permitting requirements.

All these are however only an initial part of a process that must be continued, stimulated and improved, keeping strong communication and articulation among all stakeholders, to successfully implement a geothermal industry that, together with other clean and renewable sources of power generation (such as solar and wind), can

substantially contribute to the diversification of the energy matrix and the sustainable development of the Peruvian economy.

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INTRODUCTION

High economic growth rates, macroeconomic stability, trade openness and financial liberalization are some of the drivers of Peru's remarkable growth. With economic growth, increase in energy demand has also occurred, posing significant challenges to the national power generation system. With an estimated potential of nearly 3,000 MWe (Battocletti et al., 1999, MEM-JICA, 2012), geothermal energy can contribute to filling the energy demand. The autochthonous, clean and renewable character, as well as the multiple uses of geothermal resources, can have a positive impact on Peru's environmental and socio-economic development. Peru's geothermal potential, political willingness and regulatory framework have attracted public and private initiatives. In recent years, Peruvian government institutions, international development agencies and private interests have taken action in diagnosing, proposing and implementing activities leading to the realization of a geothermal industry in the country. However, despite all the potential and interest, Peru has not yet been able to generate a single watt of electric power from geothermal sources. This document presents some of the aspects and actions that have shaped the current geothermal development in Peru; it also offers some ideas for improving the conditions for current geothermal initiatives.

The arguments presented in this document are divided in five sections. The first one discusses some of the opportunities that Peru currently offers for geothermal development. The second section describes the main factors that shape the current geothermal development in Peru. The third presents some concepts and actions that can improve the current geothermal development in Peru. The fourth section presents a summary of achievements accomplished by the geothermal sector in Peru, after applying concepts and actions described in the document. The last section corresponds to conclusions and recommendations to promote geothermal development in Peru.

I. OPPORTUNITIES FOR GEOTHERMAL DEVELOPMENT IN PERU

Peru offers interesting opportunities for geothermal development. This section briefly refers to: 1) Economic growth and its associated energy needs; 2) Geothermal resource availability and its strategic location and; 3) Geothermal development and the politics of water use.

I. 1. Economic Growth – Energy Demand in Peru

According with Peru's Central Reserve Bank (BCRP) during the year 2013 Peru's GDP grew 5.0% (BCRP, 2014). These numbers place Peru among the fastest growing economies in Latin America (World Bank, 2014).

With economic growth comes energy demand. This situation has been reflected in the remarkable growth in Peru's energy production with an increase of more than 122% between 2001 and 2012 (Figure 1).

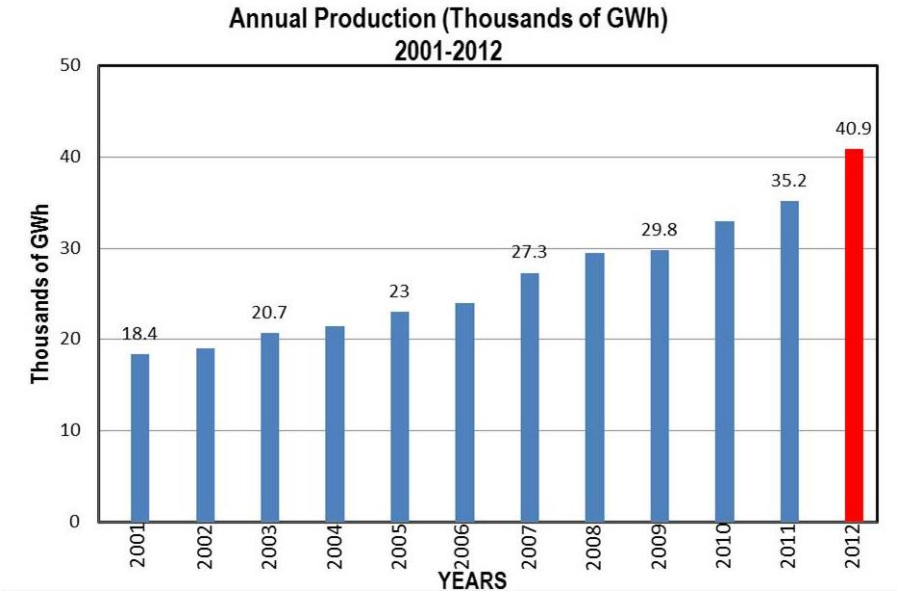


Figure 1 - Increase in energy production (GWh) Peru 2001-2012. Adapted from GART-OSINERGMIN and INEI statistics, 2012 (OSINERGMIN, 2012a & INEI, 2013).

According to Peru's Ministry of Energy and Mines (MEM, 2013), it is estimated that for the next 4 years there will be a yearly average growth of 8.8% in energy demand (Table 1).

Table 1 - Electric power demand 2012 and forecast 2013- 2017 in Peru (MEM, 2013).

MWe	Year	% annual increase
5,291	2012	6.6
5,698	2013	7.7
6,267	2014	10.0
6,875	2015	9.7
7,526	2016	9.5
7,992	2017	6.2
2013-2017	Average	8.8

Currently the demand is essentially met by hydro (~52%) and thermal (natural gas, ~45%) with marginal contributions from wind, diesel, biomass and coal. Figure 2 shows an example of energy demand and corresponding supply by generation sources during a maximum consumption peak on May 20, 2014 (COES/SINAC, 2014).

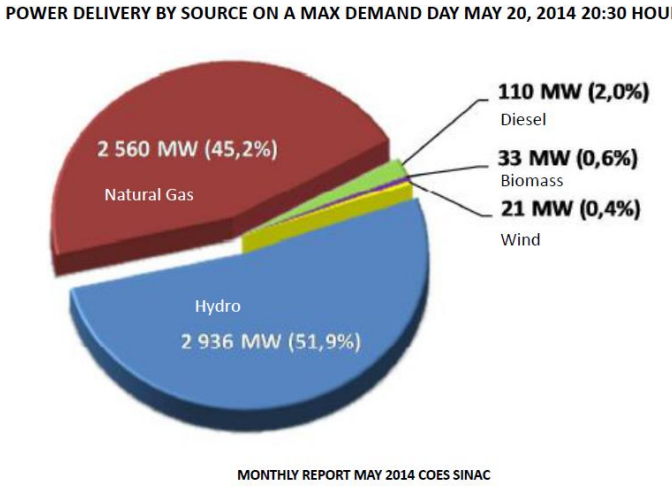


Figure 2 - Energy Demand and Source Participation on May 20, 2014 (COES/SINAC, 2014).

As noted above, Peru's energy supply relies heavily on hydro and natural gas sources. Both sources are vulnerable to environmental impacts and social events. Natural events such as droughts, floods, geological hazards (e.g., earthquakes, landslides) can affect water supply and infrastructure integrity. With similar potential impacts on generation, there have been social concerns associated with the construction of large hydroelectric projects and gas transportation facilities posing serious challenges to the granting of social licenses.

There is also the issue of hydro infrastructure maintenance (e.g., solids removal from upstream dam impoundment basins) and retrofitting and replacement of obsolete equipment that can generate serious supply shortages. MEM estimates that retirement of obsolete hydro generation units could reduce generation by 140 MWe for the period 2013 – 2017; low precipitation periods could further reduce hydroelectric generation capacity by an estimated 22%. An additional blow to the system is the Mantaro hydroelectric complex (in operation since 1973) that could further reduce generation capacity by 880 MWe (17% of the country's generation capacity). On the natural gas front, problems with the Camisea gas field and supply could represent a shortage of up to 2,360 MW (~40% of the national power offer) (MEM, 2013).

In this context, renewable and more environmentally friendly sources of energy, such as geothermal are needed and can play an important role in the fulfilment of the demand and the diversification of the energy matrix Peru needs for continual growing. Geothermal offers a unique opportunity to integrate a clean, renewable and autochthonous, power source to the energy mix.

I. 2. Geothermal Resource Availability and Its Strategic Location

Geothermal energy utilizes the Earth's naturally occurring heat to generate power. It is clean, sustainable, and provides energy around the world through a variety of applications and types of resources. The installed geothermal capacity for power generation worldwide is currently just over 12 GW, and it is growing at a sustained annual rate of 4-5% (GEA, 2014).

Peru is part of the Central Andes that constitutes a typical mountain range, associated with tectonic processes such as subduction between the oceanic plate of Nazca and the continental plate of South America. Magmatism is linked to this process and is the main factor for the varied and abundant mineralization that occurs throughout the Andean region of Peru. Large faults and other structures associated with tectonism have controlled mineralization. Similarly, these structural systems coupled with active volcanism in the South of the country are key factors for the geothermal potential of the Peruvian territory.

The extensive Quaternary volcanism, associated with anomalous high heat flow, found in southern Peru, favors the presence of important hydrothermal systems as shown by lots of geothermal surface manifestations in form of hot springs, mud pools, fumaroles and steam vents. It is important to note that in the Northern and Central regions of Peru, volcanic activity ceased 8 million years ago (Marocco, 1980) but active faulting and uplift continued, creating pathways for the upward flow of hot geothermal waters and the formation of fault-controlled geothermal systems.

Evidence of Peru's geothermal potential comes in the form of more than 500 groups of thermal springs and steam vents located throughout the country. These springs have been documented in a series of publications by INGEMMET (Peru's Geological Survey). Six broad geothermal regions have been identified in the country (Figure 3), the northern and central regions are characterized by tectonically controlled systems related to young faulting and rapid uplift, while the southern two regions include structurally controlled as well as magmatic systems, related to the active/recent volcanic cordillera.

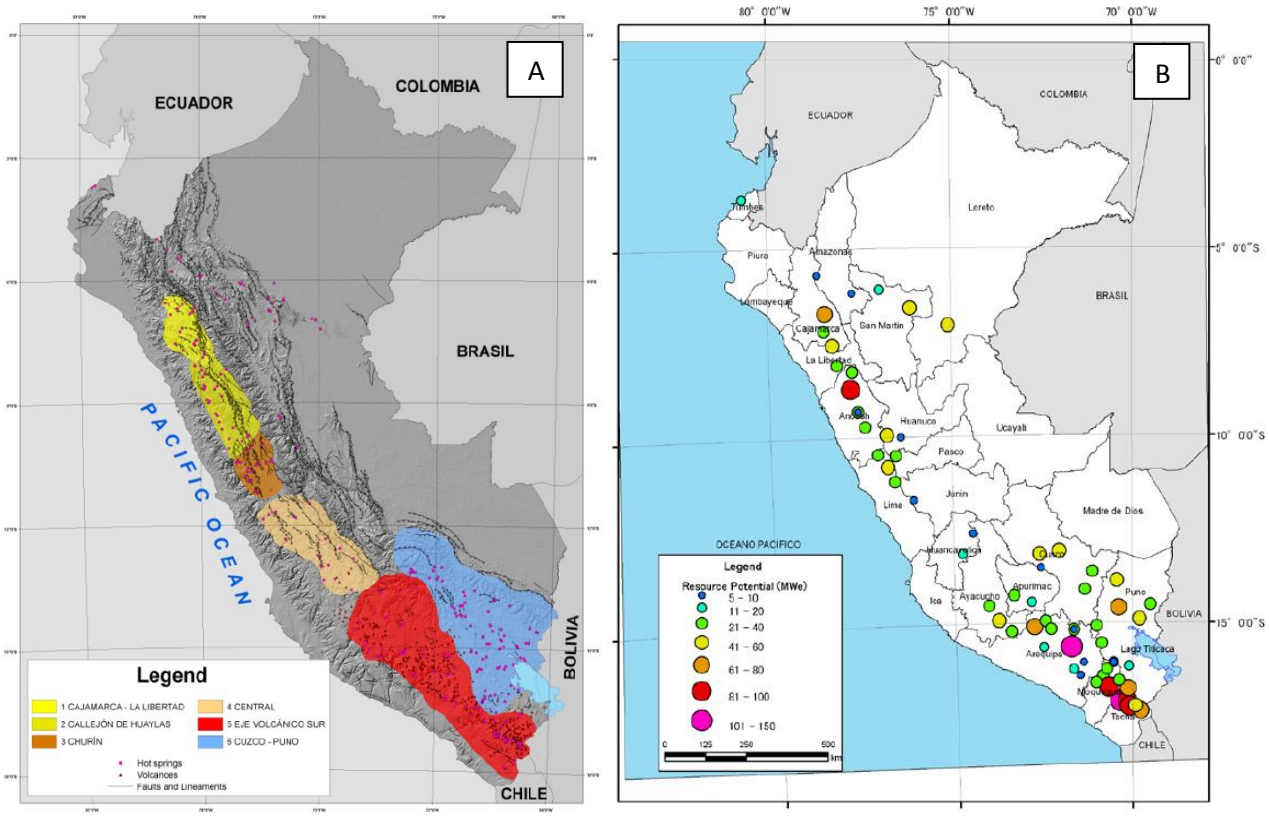


Figure 3 - A) Geothermal regions of Peru (Vargas and Cruz, 2010). B) Map of geothermal power potential of Peru (MEM-JICA, 2012).

The "Master Plan for Development of Geothermal Energy in Peru", prepared by the Peruvian Ministry of Energy and Mines and the Japan International Cooperation Agency (MEM-JICA, 2012) identified 61 geothermal prospects

and estimated the geothermal potential of Peru in 2,860 MWe (Figure 3). It is, however, important to underline that this number has to be taken with care, since geothermal development faces high exploration risks and upfront investments that significantly challenge the development of the resource. For example the "real" capacity installed by the main geothermal countries, after several decades of development, is mostly less than the total Peruvian estimate (e.g.: USA: 3,187MWe, Philippines: 1,904 MWe, Indonesia: 1,333 and Mexico: 1,005 MWe; GEA, 2014).

One of the key characteristics of Peru's geothermal resources is that they are strategically located in areas of largest energy demand from industrial operations (mainly mining activities). Figure 4 shows the location of the two most important geothermal regions in relation to big mining projects in Southern Peru. According to the Energy and Mining Investment Supervising Bureau (OSINERGMIN) the development of geothermal resources in the south could increase installed generation capacity in an area where there are mining projects for an estimated of US$ 32 billion (OSINERGMIN, 2012b).

Figure 4 - Two of the most prospective geothermal areas in Peru (Southern Volcanic (red) and Cusco (blue)) in relation to large mining projects (from Munoz-Carmona et al., 2013. GEOCATMIN compilation).

I. 3. Geothermal Development and the Politics of Water Use

One of the most important opportunities for geothermal development in Peru is related with the "politics" of water use. Water is one of the most contested goods in the context of resource development, such as mining, energy and water management.

In the mining industry, especially with hard rock mines, water is used in all steps of the process, from separating waste from valuable minerals, to cooling equipment, to controlling dust. For the energy industry, according to Ban Ki-moon, Secretary-General of the United Nations, "*water and energy are inextricably linked. Water is essential for the production, distribution and use of energy*" (WWAP, 2014, p. iv). Energy in turn "*is crucial for the extraction and delivery of safe drinking water – and for the very safety of water itself. People everywhere - but especially the most vulnerable and marginalized - face great risks when access to either is limited or compromised*" (Ban Ki-moon, WWAP, 2014, p. iv).

Different types of energy generation have different impacts on water resources. Ecosystems in particular can be impacted by many processes associated with the water-energy relationship. These systems "*provide the enabling environment for water flows as well as energy provision*" (WWAP, 2014. p. 77). Water is used for direct power generation in hydropower plants or for cooling in thermal generation plants. Water is also fundamental in the generation of biomass energy since it is important for the delivery of ecosystem services (e.g., nutrients for the soils), and therefore the existence of forest systems and generation of biomass resources.

The relationship between water, energy and the environment is especially relevant in many regions of Peru, where one of the most common and strong demands from the communities is the protection of the water sources for their use in agriculture and for human consumption (c.f., Cereceda, 2007). Several important mining projects such as Conga (gold development with an US$5 billion investment), Tía Maria (copper development with a US$1 billion investment), and hydroelectric projects like Puno's Inambari (2,030 MWe), have been suspended or delayed as a consequence of conflicts with communities which adduce water demand and the associated socio-environmental impact as their main concerns.

According to United Nations World Water Assessment Programme (WWAP), "*from a water perspective solar, photovoltaic and wind are clearly the most sustainable sources of power generation. However, in most cases, the intermittent service provided by solar photovoltaic and wind need to be compensated for by other sources of power which, with the exception of geothermal, do require water to maintain load balances*." (WWAP, 2014, p. 4).

Most of the concepts mentioned above have been considered in the WWAP 2014, reporting that geothermal power plants generally use and consume less water per kilowatt-hour of lifetime energy output than other electric power generation technologies. Recent studies (Clark et al., 2013) have shown that several geothermal power generation techniques, particularly hydrothermal binary, hydrothermal flash, and geopressured geothermal are among the lowest fresh water consumers per lifetime energy output when compared with other power generation technologies (Figure 5).

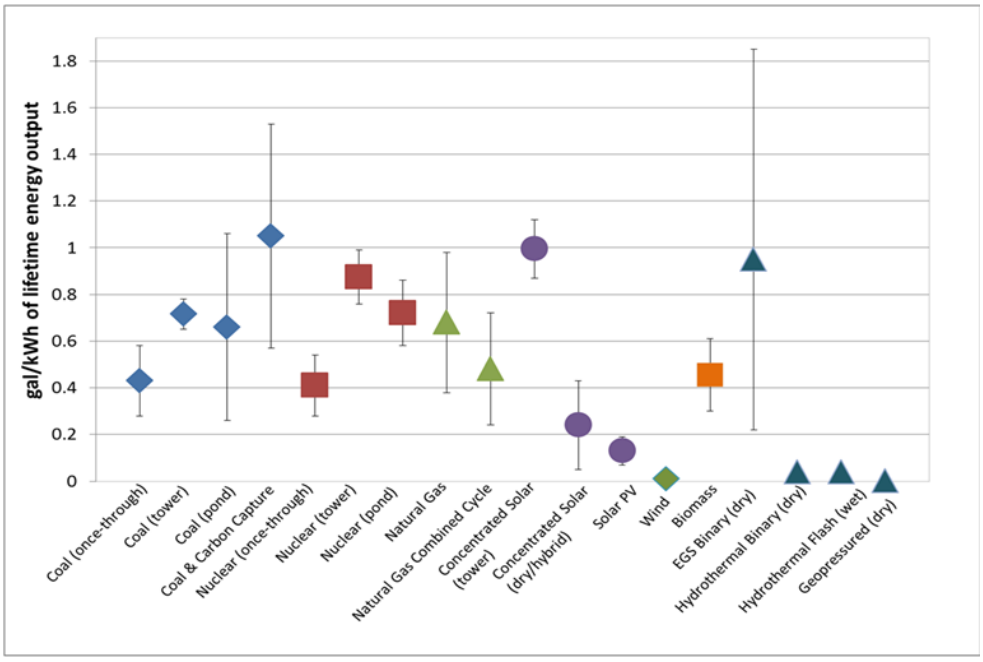


Figure 5 - Water consumption (in gallons per kilowatt-hour) per lifetime energy output of various electricity generation technologies (Clark et. al. 2013).

As mentioned before, many of the most attractive geothermal resources, particularly in Southern Peru, occur in areas where there are important mining resources. In many of these areas, water is not abundant (MEM-JICA, 2012). Geothermal developments with their relatively low water use could then contribute to mitigate the social tensions derived from the relationship between resource utilization and water conservation. In addition, many of the geothermal areas are located at high elevations, which make the multi-purpose use of geothermal energy (i.e. not only power generation, but also direct uses of heat) even more attractive and convenient (MEM-JICA, 2012).

In geothermal activity, water is mainly required for drilling wells and civil works. This is a temporary and relatively reduced consumption. Then, during operations, the water demand becomes mostly limited to supply for domestic uses in the geothermal installations and support facilities, since geothermal plants often use their own produced fluids, or air, for cooling. A geothermal flash plant typically works with a minimal loss of around 10-15% of the total geothermal fluids extracted from the reservoir. In the case of binary plants, using heat exchangers, this minimal loss tends to zero.

The geothermal fluids are brines that come from deep reservoirs, and are different from the surface and shallow ground waters used by other energy installations (i.e. hydro, cooling in thermoelectric units) and industrial operations. Additionally, the temperature and chemical composition of geothermal fluids make them unsuitable for many other uses, so their exploitation is not in conflict with other applications. One of the more frequent concerns with extraction and use of geothermal fluids is their potential interaction with shallow aquifers and surface waters, but in modern geothermal technologies, all geothermal waters are managed in a closed circle and returned to the deep reservoir through injection wells. In the subsoil, any artificial interaction between geothermal fluids and shallow ground waters is avoided since geothermal wells (for both production and reinjection) are completely cased from surface down to the top of the reservoir.

Water and energy are drivers and are driven by social development and economic growth (WWAP, 2014). Natural resource extraction and exports will continue fueling Peru's socio-economic development. With it, the demand for electricity and water will continue to grow. Geothermal energy offers an alternative that together with other clean and sustainable sources of power generation (such as solar and wind) can substantially contribute to water conservancy actions required by Peru.

II. SHAPING FACTORS OF GEOTHERMAL DEVELOPMENT

Geothermal development can be shaped by many factors. This document discusses four of them: 1) Geothermal and social context knowledge; 2) Political and policy framework; 3) Regulatory framework; 4) Infrastructure and implementation support.

These factors constitute a cycle in which each of them interact by informing each other in the path to action (Figure 6). In this representation, knowledge background is about the country's capacity to identify, assess, characterize, inform and manage geothermal resources. Knowledge background is also about the understanding of the human, cultural, socio-economic context (local, regional, national, international) where the geothermal resources occur. Human knowledge, cultural beliefs and socio-economic conditions shape geothermal development.

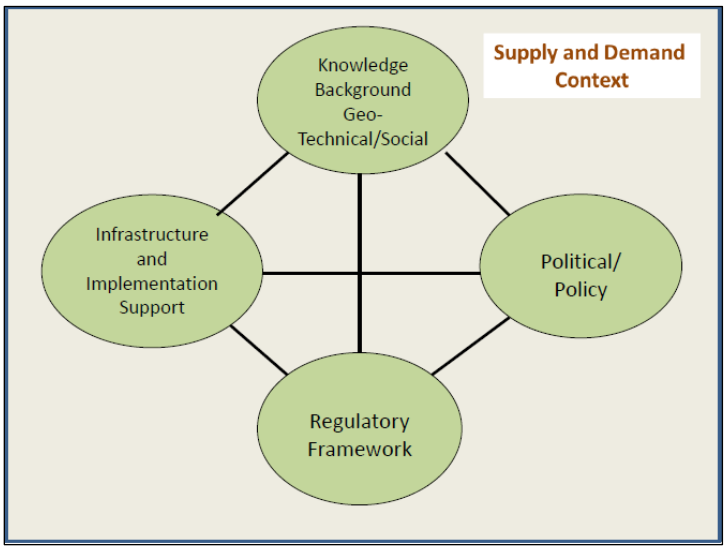


Figure 6 - Four contextual factors of geothermal development.

Geothermal knowledge background (geo-technical and social) informs the political actions[1] and the writing of policies for geothermal development. Knowledge is the basis for informed decision-making, which is intrinsically related to the exercise of political power. Political behavior has been recognized as an intrinsic aspect of decision making (Child et al., 2010) and political stances shape the writing of policies that facilitate action.

But, just knowledge, political will and policies are not enough for action. A regulatory framework is needed, to delineate rights, duties and responsibilities of those involved. The participants in the geothermal development need to play by clear, consistent, achievable and fair rules.

However, as sometimes happens, knowledge, political willingness and regulatory framework are not sufficient for action. To achieve the establishment of an initiative like geothermal power production, infrastructure and resources for implementation need to be in place. Infrastructure and resources such as institutions, trained personnel, and financial means are necessary for implementing knowledge, political willingness, policies and regulations in the context of geothermal development.

[1] Understanding "politics" as who gets what, when and how (Lasswell, 1958) or, the authoritative allocation of values (Easton, 1965) or, a strategy for integrating "the unbalanced, heterogeneous, unstable, and tense force relations" (Foucault, 1980, p. 93).

In Peru, each of these factors is characterized by strengths and weaknesses which analysis can provide ideas about the actions to follow to ensure the success of the geothermal initiative.

II. 1. Knowledge Background

In order to develop the geothermal resource, a country must have the capacity to identify, characterize, assess, inform and manage geothermal resources.

In addition, geothermal resources do not exist in a void or bubble. They exist in human, cultural, social and economic contexts that should be taken into account when developing those resources. Therefore it is very important to acquire and generate a rigorous, accessible and pertinent knowledge base for both: the geothermal resource and the context in which it exists.

II. 1. 1. Geothermal Resource Knowledge

Peru, intermittently has been the object of geothermal exploration during the last 40 years. Since 1970, there have been several studies to identify and assess the geothermal potential of Peru. The Peruvian government has signed agreements with national and international entities in order to assess and characterize the geothermal potential of the country (Fidel, 2008; Vargas and Cruz, 2010; MEM-JICA, 2012, Claros, 2014).

One of the most recent resource evaluation was performed by Peru's Ministry of Energy and Mines (MEM) and the Peruvian Geological Survey (INGEMMET) with the assistance of the Japanese Government, via the Japan International Cooperation Agency (JICA). The Master Plan for Development of Geothermal Energy in Peru is one of the results of this effort (MEM-JICA, 2012). In this document, the geothermal potential in Peru was estimated in 2,860 MWe. This number is the result of reconnaissance and prefeasibility level studies. Only three areas (Tutupaca, Calientes and Borateras, in the Tacna Region) have the studies performed under MEM's initiative expanded beyond basic surface geology and geochemistry to include magneto-telluric (MT) surveys, one of the fundamental geophysical methods used in the early stage exploration for geothermal resources (MEM-JICA, 2012).

The release of geothermal regulations in April 2010 (Decree No. 019-2010-EM[2]) increased interests from the private sector, and several foreign and national geothermal companies applied for government authorizations for geothermal exploration. By June 30, 2014, MEM had granted to seven companies 29 authorizations covering an area of 272,500 ha.

Some of these companies have performed additional reconnaissance and prefeasibility level studies. One of the companies has also performed additional MT surveys in the Tutupaca and Ticsani areas (Moquegua Region) and continues to actively explore. No drilling of exploratory wells has been conducted so far, therefore no accurate estimate of the geothermal resources and their characteristics are available yet, and the present information and knowledge is not enough to design a development program (MEM-JICA, 2012). More exploration and more studies are needed to define technically and economically feasible projects.

The lack of detailed exploration studies contributes to the high level of uncertainty regarding the actual geothermal reserves. This uncertainty has very significant implications for the realization of a geothermal project. One of the characteristics of geothermal development is the very high initial costs to determine the viability of a geothermal prospect. Investors and banks do not like high degrees of uncertainty. It is like a vicious circle. Money is needed for exploration that reduces uncertainty but with large uncertainty there is no money.

[2] Decreto Supremo No. 019-2010-EM. Reglamento de la Ley No. 26848, Ley Orgánica de Recursos Geotérmicos. El Peruano, April 8, 2010.

Under the current global economic environment (reduction of funds for resource exploration and management) very few companies have the capacity and the financial resources to embark on such high risk investments. It is suggested that government co-participate with financial and human resources to carry out the detailed and exhaustive evaluation and assessment of geothermal resources. The more quality knowledge about the resource is available, the more attractive a geothermal project becomes.

II. 1. 2. Cultural and Socio-Economic Context Knowledge

At the time the geothermal regulations were enacted in April 2010, authorities at the regional and local level, and the inhabitants of the prospective geothermal areas, had not been informed about geothermal energy. There was no coordination between the different levels of government (national, regional and local), the geothermal companies and the communities.

The understanding of the cultural and socio-economic context for geothermal development in Peru was (and still is) very limited. The Peruvian government had not generated, proposed or developed structured actions for the identification and evaluation of the cultural and socio-economic characteristics and expectations of those related with geothermal development, particularly local communities. There is a broad variety of social groups and communities with different world visions, cultural and socio-economic backgrounds and interests that need to understand geothermal, and also need to be understood. This information and knowledge is very important for the creation of processes and platforms where the participants of the geothermal initiative (stakeholders and shareholders) exchange the information, knowledge and resources that shapes the course of geothermal development.

For geothermal development to be successful, it requires keeping the information exchange dynamics and articulation between the involved parties, continuously adjusting to the changing context. In this process, communication, (discussed in section II.3), is crucial. The acquisition of rigorous knowledge, about not only the geoscientific and engineering characteristics of the resource, but also of the cultural and socio-economic aspects of the context where geothermal resources exist, should continue, and the information generated should be compiled in an organized and accessible manner.

The Peruvian resource extraction and development sector has an important experience in dealing with and managing social context issues. The mining, hydrocarbon, and energy industry, environmental services companies and NGO's have very important experiences that should be communicated, shared and used by the geothermal industry. These actions will facilitate stakeholder's access to geothermal knowledge and understanding. This knowledge is needed when identifying the sustainable initiatives that will benefit the development of the geothermal initiative and in particular, the stakeholders involved.

II. 2. Political and Policy Framework

To advance geothermal, a politically favorable environment is needed. Political favorability is based on clear, pertinent and rigorous information and knowledge (technical, cultural, social, and economic, etc.).

For indigenous people, earth/land is not only an object of possession and production; it is the autonomous entity that represents the very basis of their existence in physical and spiritual terms. The territorial space is the foundation of their relationship with the universe and the livelihood of their worldview (UNESCO and FLACSO, 1981). According to Dr. Vicente Alanoca, an Aymaran anthropologist from Ilave (Puno Region, Peru), in the agro-centric Andean cosmo-vision there is a fundamental unity between earth, water, culture and humans. From the

Aymara perspective the category “Earth”, the Pachamama (Mother Earth), means not just a mother but it has an intercultural-philosophical connotation that represents sacrifices and resistance (Alanoca, 2008).

In Peru, many Andean communities feel that resource developers, in particular foreign ones, have transgressed their worldviews. In recent years, there has been a notable increase in the number of social conflicts in Peru. For May 2014, the office of the ombudsman (Defensoría del Pueblo) reported on 212 social conflicts, 64% (135 cases) of which were related to socio-environmental issues. 55% of these socio-environmental issues were related to mining (47%) and hydrocarbon (8%) operations (Defensoría del Pueblo, 2014). For comparison, in April 2008, the total number of social conflicts was 93. 48% of these were related to socio-environmental issues (Defensoría del Pueblo, 2008).

The May 2014 ombudsman’s report explicitly acknowledges environmental contamination of soils and water resources in areas inhabited by Achuar, Quechuas, Kichwas and Kukamas indigenous communities. The report, which is a government document, also indicates the need to urgently remediate the affected areas providing clean water and treating systems for contaminated water, validating and accepting the request for actions from these communities.

As it was already mentioned, several important resource development projects (mining, energy) have been suspended or delayed because of social conflicts. An interesting fact is that the sources of the leadership for these protests comes from different geographical jurisdictions (national, regional, local, North, South, etc.). For example, the mayor of Candarave, a small town of 3,000 people in southern Peru, has been at the center of the social license negotiations for Southern Peru Copper Corporation’s Toquepala’s mine expansion (addition of a second concentration plant) investment estimated in US$ 1 billion. At the regional level, the President of the Cajamarca Region in northern Peru has been a key political player in the social license negotiations of Newmont’s US$5 billion development of the Conga gold mine. These situations highlight the influence of the various political levels and the need for communicating, engaging and articulating with authorities and representatives from different levels, jurisdictions and sectors.

The Geothermal industry ought to avoid similar negative situations that are affecting other resource utilization sectors. The geothermal industry needs to identify, map and work with all the key stakeholders in understanding the critical aspects of their relationships (e.g. social, organizational protocols, interests, resources) for implementing action. As Porter and Krammer (2006) have indicated, it is time to stop talking about Corporate Social Responsibility and instead start thinking and acting in terms of Corporate Social Integration. There should be a shift in focus from the often-common view of the tension type of relationship between business and society to an interdependence type of relationship between them.

Political considerations are important for the generation of new policies and the implementation of existing ones. According to the Ministry of Energy and Mines (MEM), these policies should aim at securing energy self-sufficiency in a competitive environment through the promotion of private investment (MEM-JICA, 2012).

The increasing energy demand has prompted authorities to formulate policies for the development and the advancement of the energy sector that can benefit the geothermal industry. The long-term vision of MEM for the energy sector is expressed in Peru's National Energy Policy 2010-2040, approved by Supreme Decree (No. 064-2010-EM[3]) in November 2010. According to this document, the objectives of national energy policy are as follows:

1. Having a diversified energy mix, with emphasis on renewables and energy efficiency.

[3] Decreto Supremo No. 064-2010-EM. Aprueban la Política Energética Nacional del Perú 2010-2040. El Peruano, November 24, 2010.

2. Having a competitive energy supply.
3. Universal access to energy supply.
4. Having greater efficiency in the production chain and energy use.
5. Achieving self-sufficiency in energy production.
6. Development of the energy sector with minimal environmental impact and low carbon emissions in a sustainable development framework.
7. Development of the natural gas industry, and its use in household activities, transportation, trade and industry as well as efficient power generation.
8. Strengthen energy sector institutions.
9. Integration with the region's energy markets, capable of achieving long-term vision.

Additionally, new regulations and actions have been proposed and implemented since 2010 providing incentives for the development of renewable energy sources. Up to 5% of the total electric power generated (excluding hydraulic power) must come from renewable sources and the percentage participation of renewables will be increased every five years. Based on Legislative Decree 1002[4] and Supreme Decrees Nº 050-2008-EM[5] and N° 012-2011-EM[6] (this last replaces the previous one, issued in 2008) that promote investments for electricity generation from renewable sources, three energy auctions for renewable energy have taken place between 2009 and 2013. Geothermal resources were not included in these auctions because no projects with proven reserves were yet available.

These policies and the regulatory framework (summarized below) promoted by the Peruvian government have favored the development of two main geothermal initiatives. The first one has been led by MEM through an official agreement with international entities like the Japanese Government via JICA. As a result of the Peru-Japan agreement, MEM has generated the Geothermal Master Plan. This Plan is a very important reference document for the future development of the geothermal industry in Peru. The second initiative is derived from the geothermal regulations released by the government in April 2010. Under this initiative several foreign and national geothermal companies have been performing exploration and social context studies, review of the regulatory framework, and governments and communities' engagement activities.

However, despite the policies in place, the available regulations and the notable commitment from many government officials (especially from INGEMMET and MEM-DGE), the development of geothermal energy is not a priority when comparing with other power sources (hydro, gas) (Claros, 2014).

It has not been possible to achieve continuous communication and coordination between the different geothermal initiatives that exist in the country. A more prominent role of a referent government entity is necessary in the discussion, exchange and articulation of the different initiatives currently in process in the country. The lack of coordination extends to the different government entities related with geothermal development: Supervisory Organism for Investment in Energy and Mining Sectors (OSINERGMIN); Directorate General of Energy Environmental Affairs (DGAAE); Directorate General of Electricity (DGE); Geological Mining and Metallurgical Institute (INGEMMET); Committee of Economic Operation of the National Interconnected System (COES-SINAC);

[4] Decreto Legislativo 1002. Ley de Promoción de la Inversión para la Generación de Electricidad con el Uso de Energías Renovables. El Peruano May 2, 2008

[5] Decreto Supremo No. 050-2008-EM. Aprueban Reglamento de la Generación de Electricidad con Energías Renovables. El Peruano, October 2, 2008.

[6] Decreto Supremo No. 012-2011-EM. Nuevo Reglamento de la Generación de Electricidad con Energías Renovables. El Peruano, March 23, 2011.

Directorate General of Rural Electrification; and the Directorate General for Efficient Utilization of Energy and Regional Governments.

Information, knowledge and political willingness alone do not automatically translate into action. The participants of the geothermal initiative need to play by clear, consistent, achievable and fair rules.

II. 3. Regulatory Framework

The regulatory framework in Peru is very rich in laws and regulations that promote renewable energy, including geothermal.[7] One of the most important ones is the Law No.1002[11] to Promote Electricity Generation with Renewable Energy (May 2008) and its Regulation, initially the Supreme Decree No. 050-2008-EM (October 2008)[12], then replaced by the Supreme Decree No. 012-2011-EM on March 2011[13]. There is also the Law No. 1058, (June, 2008) to promote investment in the electricity generation activity with other water and renewable resources and, the Cogeneration Regulations No. 037-2006-EM (July 2006) that establishes the requirements and conditions for qualifying cogeneration plants involved in the electricity market (MEM-JICA, 2012). There are also laws and regulations that provide legal frameworks for natural and socio-environmental concerns. Public participation and information disclosure are regulated by several mandates among the most important, Article 46 (Public participation) and Article 51 (Standards of general public participation procedures) of the General Environmental Law No. 28611.

When geothermal resources are located in natural protected areas, there are additional laws and regulations that apply such as the Protected Natural Areas Law No. 26834, and its regulations (Decree No. 038-2001-AG). There are also laws and regulations for the protection of cultural assets for example; the Law of the Cultural Heritage of the Nation No. 28296 which stipulates the assets that have cultural heritage. Another important aspect that is covered by laws and regulations is the one related with the categorization and management of water resources such as Decree No. 002-2008-MINAM.

The law that directly promotes geothermal development is the Organic Law on Geothermal Resources (Law No.26848) promulgated in July 1997[8], and its Regulations which were passed in 2006[9], later replaced in April 2010 (Supreme Decree No. 019-2010-EM[10]) and modified in May 2013 (Supreme Decree No. 015-2013-EM[11]). The law and the subsequent regulations were approved with the objective of allowing private investment in developing geothermal.

It is a remarkable fact that, in South America, Peru and Chile are the only two countries with geothermal law and regulations. In the case of Peru, another important feature of its regulatory framework is that it is still in initial phase of application and subject to improvements and modifications. For example, the Peruvian government, acting on the recommendation made by a multi-institutional working group, recently changed the regulations to address an issue with exploration periods and granting of environmental permits.

After few years of experience, both from private companies and government institutions, managing geothermal applications and exploration permits, other important gaps are already identified and should be addressed in order to strengthen the geothermal legal framework of Peru. Most of them deal with: ambiguity in certain writing of the

[7] MEM's Geothermal Master Plan presents a comprehensive list and description of the different Laws and regulations.

[8] Ley No. 26848. Aprueban la Ley Orgánica de Recursos Geotérmicos. El Peruano, July 29, 1997.

[9] Decreto Supremo No. 072-06-EM. Reglamento de la Ley Nº 26.848, Ley Orgánica de Recursos Geotérmicos. El Peruano, December 23, 2006.

[10] Decreto Supremo No. 019-2010-EM. Reglamento de la Ley Nº 26.848, Ley orgánica de recursos geotérmicos. El Peruano, April 8, 2010.

[11] Decreto Supremo No. 015-2013-EM. Modifican el Reglamento de la Ley No. 26848. Ley Orgánica de Recursos Geotérmicos. El Peruano, May 25, 2013.

regulation and regarding the environmental instruments needed for the different exploration phases; issues related with delays for obtaining social licenses; lack of rules for participation of public/government institutions in the geothermal sector; lack of regulation for non-electric uses of geothermal resources.

II. 4. Infrastructure and Implementation Support

II.4. 1. The need for Articulating Laws and Institutions Related with Geothermal Development

Laws and regulations set the rules that participants of geothermal development must follow to guarantee a legal, fair and transparent process. Without diminishing the importance of the existence of clear rules, it is equally important the continuous and effective articulation between the different laws from the different sectors and the different stakeholders that propose and enforce them. For example, there is not a single governmental entity in Peru that has comprehensive authority over the environmental impact assessment (EIA).

According to MEM's Geothermal Master Plan, different ministries take charge of EIA according to the nature of projects. The Ministry of Environment (MINAM) was established to take charge of formulating environmental management rules to ensure sustainable and strategic development of natural resources, managing protected areas and conducting research of the indigenous people in the Amazon River basin. However, examination of the EIA contents is not included in its responsibility, and MINAM is not involved with the EIA procedures for power development projects. The National Protected Natural Areas Service (SERNANP: Servicio Nacional de Áreas Naturales Protegidas) is an institution under MINAM with the authority to grant permission for activities within protected areas and gives technical opinions on EIA submitted. EIAs for power development projects are reviewed and approved by the Directorate General of Energy-related Environmental Affairs (DGAAE; Dirección General de Asuntos Ambientales Energéticos) of the Ministry of Energy and Mines (MEM; Ministerio de Energía y Minas), while environmental rules and regulations are managed by the Directorate General of Electricity: (DGE, Dirección General de Electricidad) (MEM-JICA, 2012. p. 31). In addition, if the geothermal prospect is located in a regional protected area, the respective regional environmental office needs to provide the environmental instrument that subsequently SERNANP considers when reviewing the EIA.

Since the geothermal industry is very young in Peru, an initial period of uncertainty is normal; however, there has been active exploration in Peru by several companies for more than five years. There has been a clear call by these developers for clarity and acceleration of the bureaucratic processes necessary for granting geothermal exploration and geothermal development. Despite the government officials' willingness to cooperate, the geothermal companies operating in Peru struggled in many occasions in obtaining the documents and requirements necessary to initiate exploration activities. In many occasions, even within the same institutions (aggravated by high personnel rotation rate), there was no "memory" of the different regulations and processes, generating vague or contradictory responses and directions. This delayed the permitting process for months to more than a year.

However, that said, there has been a positive attitude by government officials willing to work on these issues in a coordinated fashion with companies representatives. Some of the issues were solved, as for example, the enactment of the latest improvement of the geothermal regulation (Decree No. 015-2013-EM, May 2013). One of the teachings of this process was that the problem is not the current number of laws, regulations and entities in charge of enforcing them, but also the lack of articulation among those laws, regulations and entities.

II. 4. 2. Strengthening Infrastructure for Implementation

II. 4. 2. 1. Strengthening of the Human Resource and Institutional Capability

According to MEM's Geothermal Master Plan, the "*long absence of large scale geothermal projects, coupled with the fact that the organizations which lead the earlier studies have been restructured, the expertise on this technology has not been well maintained*" (MEM-JICA, 2012, p. 50). Therefore, little technical expertise is "*present in the governmental organization in the area of resource development technologies, including geothermal well drilling and geothermal power plant technology, while the capacity building program in this area is barely existent*." (MEM-JICA, 2012. p.51-52).

The reduced number of trained personnel has been especially evident during the application granting process. The request for geothermal authorizations involves an important volume of information. Each of the application packages include detailed technical, legal, social and geographical information that requires careful and expert analysis. Because of budget restrictions, and the lack of available skilled personnel, the number of officials involved is not enough to handle the considerable amount of work involved in the reviewing process. In addition, capacity building is intermittent since personnel rotation is quite common, for reasons that are not under the control of the respective institution.

For the geothermal industry to be successful in Peru there is a need to be built a critical mass of stable, highly qualified personnel, state of the art research/processing equipment, and financial resources capable of leading the stakeholders' articulation process; generating, communicating, delivering and applying high quality, pertinent and rigorous geothermal-related knowledge (e.g., geoscience, engineering, social).

II. 4. 2. 2. Geothermal Development Database

The implementation of knowledge, political stances, policies and geothermal related regulations requires extensive and organized use of databases, "*which consequently asks for establishing an appropriate structure in terms of the operation of the databases, for its effective utilization as well as for the rigorous implementation of the data update in order to maintain its usefulness*" (MEM-JICA, 2012, p. 83).

Currently, the information about the Peruvian geothermal resource is scattered in different reports mainly managed by INGEMMET. There is a very emerging geothermal cadaster, kept by the Directorate General of Energy at MEM, which the companies have access to upon request. The information offered consists of the coordinates and application dates for the different exploration authorization requests. At the moment there is no single or unified data base containing the findings of the different institutions, companies or initiatives. Even though it is understood that exploration information can be confidential at critical phases of a geothermal project, it is important for the government to offer a repository where all the geothermal efforts can be traced, reviewed and articulated. A Geothermal Data Base should be accessible and contain geoscience, engineering, cultural and socio-economic information to be used as an instrument for geothermal information dissemination, exchange, education and implementation. INGEMMET manages one of the best mining cadastral online databases in the world and a very comprehensive, interactive geological database (Geocatmin) in South America. This could be an excellent reference for the construction of a similar tool for geothermal users.

II. 4. 2. 3. Financial Aspects

Considering economic models proposed by MEM's Master Plan (MEM-JICA, 2012), projected geothermal power prices still look competitive when compared with current international natural gas prices. According to this

document, the economic evaluation for a 30-year operation period calculated a selling price of electricity that could attain a 12% Financial Internal Rate of Return. The lowest selling price that could achieve this return was 10.5 US cent/kWh. The cost competitiveness of the geothermal power project was compared with other alternatives such as natural gas (combined cycle power plant; NGCC), coal and diesel (MEM-JICA, 2012). The assumed fuel prices were: Oil 120 USD/bbl; coal 110 USD/ton and natural gas 12 USD/MMBTU. Current prices are in a similar range with the exception of oil which is around 100USD/bbl[12]. The results showed that geothermal can compete with gas if gas prices stay within a range of 10-15 USD/MMBTU. Depending on the geothermal field characteristics, it can also compete with diesel power projects. Against coal power projects, geothermal is less competitive in terms of prices, but this is not considering the significantly lower CO_2 emissions (MEM-JICA, 2012).

In addition, studies on costs of renewable energy show that geothermal power compares favorably with other renewable technologies (such as solar and wind) currently available (Taylor, 2013). One key difference of geothermal is the base load character, compared with the variable and intermittent power output of wind and solar, that requires significant backup capacity in the energy system to allow their connection to the grid. Recent studies have shown that when including costs, traditionally not considered when comparing between renewables, geothermal power is an affordable renewable power resource. Considering price variations by external or policy factors that can change net prices for a particular source, geothermal power shows very competitive prices when considering costs like "*grid connection, balancing costs for integration of volatile and intermittent renewable energy resources, the costs of required back-up capacity based on conventional thermal plants, or occasional capacity shedding and other additional system costs*" (Matek and Gawell, 2014 , p.2). If this new evaluation approach becomes the norm, geothermal projects will be even more attractive impacting positively on their financial viability.

However, giving the high level of uncertainty, especially in the early stages of a geothermal project before the magnitude and quality of the geothermal resource is known, obtaining funds has proved to be a very difficult task. The need for public-private partnerships and government incentives for geothermal development has become more evident.

To address this financial dilemma, recently there has been a surge of initiatives coming from banks and multilateral entities aiming to apply so called "risk mitigation funds" as an effort to manage the uncertainty and high risk associated with the assessment and definition of the potential geothermal resources. Traditionally multilateral development banks have not focused on mitigating resource risk. However, in October 2013, a $115 million Clean Technology Fund (CTF) for addressing resource risk by supporting drilling and other resource validation expenditures was approved. This initiative, proposed by the World Bank's Energy Sector Management Assistant Program (ESMAP) as part of the Climate Investment Fund (CIF) Program, seeks to facilitate private sector engagement in early geothermal development phases. These resources will be available initially for Turkey, Chile, Mexico and Indonesia. It could be expanded to other countries based on additional pledges by donors (ESMAP-World Bank, 2013).

In a similar trend, the Latin American Development Bank (CAF), the German Development Bank (KfW) and the European Economic Commission (EEC) have proposed the design and creation of a Latin-American fund for geothermal development. This initiative also supported by the Inter-American Development Bank (IDB) and the Central American Bank for Economic Integration (CABEI), points to create funds for project risk mitigation, solving specific countries' needs such as resource evaluation and technical assistance for regulation design. These funds will be available initially for Bolivia, Chile, Colombia, Ecuador and Peru (Mauricio Garrón, CAF Senior Energy

[12] See Wesfarmers (2014); Federal Energy Regulatory Commission (2014).

Specialist, in Piensa en Geotermia, April, 2014; Wirth, 2014). These initiatives add to similar ones lead by the IDB – CTF in Mexico and Chile for mitigation of geothermal exploration risk (ESMAP-World Bank, 2013).

The danger though would be to assume that these types of actions by themselves, applied in isolated fashion will solve the obstacles that make more difficult geothermal development in Peru. Without adequate background knowledge, positive political support, clear regulations, and adequate infrastructure for implementation, proposals like these will not achieve the expected success. Multilateral institutions could play a very important role promoting and supporting initiatives that aim at strengthening of the country's capability for compiling, generating, informing, communicating and applying the knowledge of the contextual aspects mentioned in this section.

III. CONCEPTS AND ACTIONS FOR STRENGTHENING THE GEOTHERMAL DEVELOPMENT IN PERU

"For geothermal energy for heat and power to claim its share of the coming energy revolution, concerted action is required by scientists, industry, governments, financing institutions and the public."

(Nobou Tanaka in International Energy Agency (IEA), 2011). P.1).

In this section, the document briefly describes three concepts that should be considered for geothermal development: 1) The consideration of a supply and demand perspective; 2) The identification and articulation of key players of the geothermal development and; 3) The role of communication.

III. 1. Supply and Demand Context for Geothermal Development

"Geothermal energy is an energy source that can unite energy developments and regional developments"

(Geothermal Master Plan, MEM-JICA, 2012).

The understanding of geothermal development in Peru can be approached from the perspective of supply and demand. From this perspective, the supply is the amount or quantity of a product or service that the marketplace can offer. The demand refers to the amount, or quantity of a good or service that is desired by buyers or users.

The relationship between supply and demand can reach a point where producers and consumers of the geothermal resource are satisfied. The concept of "satisfaction" implies very important product or service characteristics beyond the mere concept of "quantity". Satisfaction means that in order for a product or service to be offered or demanded it will have to fulfill the expectations of those involved in the process. As such, expectations for quality/reliability, price/affordability, and profitability in social, economic and environmental terms should be achieved (Figure 7).

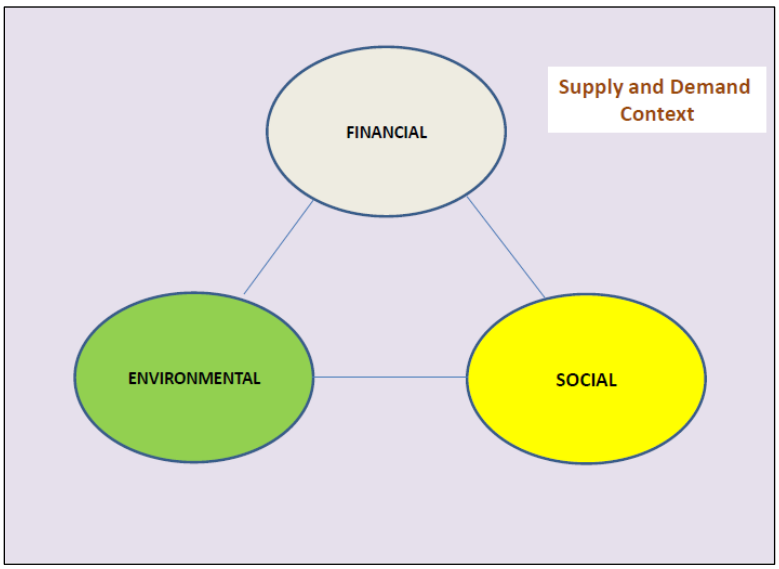


Figure 7 - Expectations to be fulfilled in the supply and demand context.

Geothermal energy offers the opportunity to provide services like electric power for communities and industries. Associated with it, a geothermal plant also provides economic benefits like business taxes, sales taxes, property taxes, lease rental payments, bonus bids, royalties to the national, regional, local governments, salaries and benefits to employees, and payments to a range of local vendors for services and products associated with electric power production (Matek and Gawell, 2014).

The geothermal industry can also provide environmental benefits like the reduction of environmental pollution and carbon emissions. But arguable for Peru, one of the most important demands that the geothermal industry could fulfill comes from the direct use of geothermal energy for heating purposes.

As previously mentioned in this document, some of the most attractive geothermal resources in Peru are located at high elevations with year round low temperatures. During the southern hemisphere winter, high elevation areas experience extremely low temperatures that on several occasions have resulted in humanitarian and environmental crisis. In 2007, Peru experienced the coldest weather in 30 years, with temperatures falling as low as minus 27°C, affecting in particular, Andean communities living above 3,500 meters. Some 700,000 people were affected, 396 houses damaged, and 47,000 hectares of cultivated land damaged. According to the Ministry of Health the event claimed the lives of 278 people, 67 of them were children under five (European Commission, 2007). Geothermal heating systems could have contributed to save many lives and to reduce economic losses. The application of geothermal heating in agriculture and aquaculture could improve food production and economic conditions making local communities less vulnerable to these extreme events.

Geothermal energy also has a very important potential for bathing and recreation. In Peru there are many geothermal manifestations already exploited for bathing and recreation purposes. The geothermal industry could provide the financial means for the development of the tourism industry by promoting and supporting productive sectors associated with this industry (e.g., forestry, hotel, restaurants and transport). One of the common complaints communities make about extractive industries is that the benefits do not stay in their communities. In contrast, productive activities associated with geothermal developments, mean job generation, as well as environmental and socio-economic benefits in the areas located within the jurisdiction of geothermal resources.

III. 2. Key Participants of the Geothermal Development

In the supply and demand context there are several entities or groups of individuals that interact representing different interests, playing different social roles and functions. This document considers Communities, Government and Geothermal Companies (Figure 8).

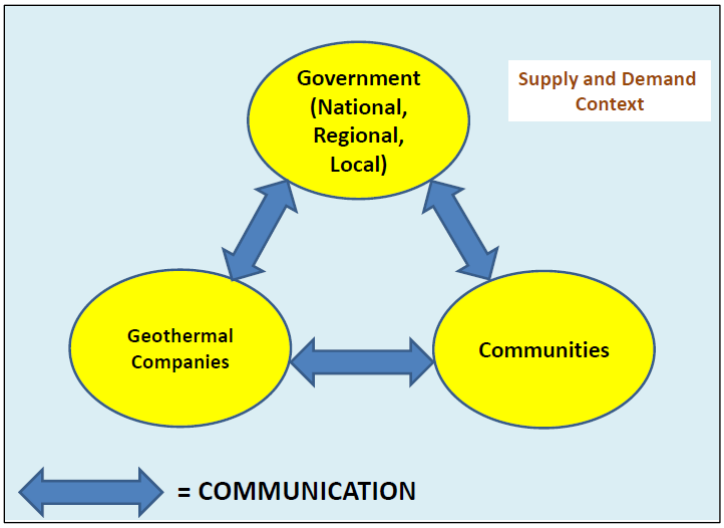


Figure 8 - Interacting groups in the Supply and Demand Context.

For communities it is understood that not only are the inhabitants in the vicinity of the geothermal resource, but also other groups (represented by professionals, academics, leaders and activists) interested in development projects. These groups bring their knowledge, expectations, concerns and experiences to the geothermal initiative. In particular, for those communities living within the jurisdiction of the geothermal development, it is very important to understand the characteristics of a geothermal development and its potential impacts, both positive and negative. For the geothermal initiative to be successful, communities need to be actively involved and engaged facilitating the exchange and articulation of knowledge and resources working towards harmonious relationships.

Government is the group of people or entities that administer public policies. These entities operate at a national, regional and local level exercising power through laws and institutions. Government is the instrument through which policies are enforced. Its role is very important since it can act as an administrator, articulator, arbitrator and legislator of the geothermal initiative. Those involved with geothermal development must follow the Law which is enforced for the different levels of government. An efficient and effective government provides the conditions for clear, smooth and fair administrative processes for all parties involved. According to E8-UN-Energy (2011), "*one of the key strengths of the public sector is the ability to develop long-term, low-risk policies that can entice financial contributors and project developers to invest in a project*" (p. 56).

By Geothermal Companies, it is understood to mean all the entities dedicated to the different aspects of geothermal development such as exploration, exploitation and, support services. Geothermal companies bring technical knowledge and financial resources, both very important components of geothermal development. In addition to maximizing the resources to achieve the best products and highest returns, they should also operate under a rationale tied to their strategies and the conditions in which they operate. In this sense, the geothermal companies should, paraphrasing Porter and Kramer (2006. p. 5), "*identify, prioritize and address the social issues that matter most or the ones on which [they] can make the biggest impact*." The geothermal industry should avoid the uncoordinated Corporate Social Responsibility (CSR) and philanthropic activities "*disconnected from the company's strategy that neither make any meaningful social impact nor strengthen the [sector's] long term competitiveness*" (Porter and Kramer, 2006. p. 5). The contribution of geothermal companies articulated with the knowledge and resources provided by government and communities facilitates geothermal development in a supply-demand context.

Communities, government and geothermal companies are key stakeholders for geothermal development. The geothermal industry in Peru needs to reach that point where the effective and sustainable use of the available resources (heat, vapor, electricity, financial) can satisfy the socio-economic and environmental expectations and demands of the stakeholders of the geothermal industry. It is about the "Social Inclusion" recent Peruvian governments have been promoting. But Social Inclusion is not just participating in endless and un-fructiferous meetings. Social Inclusion means accessing the instruments and resources for socio-economic development.

It is not just about "geothermal development." It is about a meaningful[13] geothermal development that contributes to fulfilling the expectations of those involved. To achieve meaningful geothermal development, the stakeholders must engage in a constitutive[14] interaction, promoting and contributing to the establishment of public-private partnership strategies that can facilitate the achievement of the mentioned supply and demand, "satisfying" points.

III. 3. The Role of Communication

Communication plays an important role in the establishment of communicative and constitutive relationships that shape the articulation of the different players or agents in the development of the geothermal industry. Communication is not only an instrument for informing and exchanging messages but also a process where there is participative "production of meaning," in contrast, to "distorted communication" where there is a "latent" and "strategic re-production of meaning[15]" that only benefits those with the malicious control of the communication process (see, Deetz, 1992; Habermas, 1970).

In the participative way of communication, the agents involved (the stakeholders), *"… must be free to 'call into question any proposal,' to 'introduce any proposal,' to express any 'attitudes, wishes, or needs.' There must be a 'symmetrical distribution of opportunities to contribute' to discussion. There must be adequate time to arrive at agreement. The outcome must be oriented towards agreement determined through 'good reasons,' or the 'force of the better argument,' and more.*" (Jacobson, 2002, p. 6).

By this means of communicating, feedback is encouraged from the participants of the communication process based on mutual respect and appreciation. Under this context, there is the motivation to genuinely listen, discuss and explain topics until there is understanding and consent. This communication approach facilitates the articulation and integration of the different experiences, knowledge, resources and initiatives of the agents/stakeholders involved (Figure 8). Together, the voices of supply and demand, represented by the different stakeholders and, paraphrasing again Porter and Kramer (2006), should identify points of intersection, which issue to address and create the agendas for action and; create the social dimension to the geothermal industry value proposition. Strong partnerships are based on "*effective communication, well-defined roles and responsibilities, and continuous commitment*" (E8-UN-Energy, 2011. P. 56).).

Long-term survival and success of the geothermal industry is in understanding that "*it is relationships rather than transactions the ultimate source of a company wealth and it is the ability to establish and maintain such relationships within its entire network of stake holders*" (Branco and Rodriguez, 2007. P. 13).

[13] i.e., With a clear purpose. Relevant for those related with geothermal development.

[14] i.e., essential; that it has the power to establish.

[15] Communication has a strictly utilitarian connotation. An action with a purposive-rational action oriented towards other group or person's end or objectives.

IV. RECENT INITIATIVES THAT HAVE CONTRIBUTED TO THE ADVANCEMENT OF GEOTHERMAL DEVELOPMENT IN PERU

IV. 1. Communication Effort - Articulating Stakeholders for Geothermal Development in Peru

By the time the new geothermal regulations were enacted in April 2010, authorities at the regional and local level and the inhabitants of the prospective geothermal areas had not been informed about geothermal or prepared for the administrative process. There was no coordination between key stakeholders such as the geothermal companies; the communities in the jurisdiction of the prospective geothermal areas, and the Peruvian government with its different levels of governance (national, regional, local).

In response to this lack of communication, in 2011 the geothermal companies operating in Peru (Andes Power, US based Ecoenergy, Italian based Enel Green Power, US based GeoGlobal Energy, Australian based HotRock, Canada based Alterra Power Corp./Magma Energia Geotermica Peru, and Peru based Muruhuai) formed a group which later would constitute the Peruvian Geothermal Association (APG). Representatives met with the idea of working together on common goals that would benefit and expedite geothermal development. These companies began working on two main objectives:

1. Communication/information/education about geothermal energy technology and,
2. Review and adjustment of the geothermal regulations.

With these defined objectives, the geothermal companies approached MEM's INGEMMET and the General Electricity Bureau (DGE) inviting them to work in a coordinated fashion on the above mentioned objectives and other aspects that MEM might consider necessary. The idea was to reach communities and regional and local authorities with a coordinated effort by government and the geothermal companies i.e., articulating communities, government and geothermal companies (Figure 9).

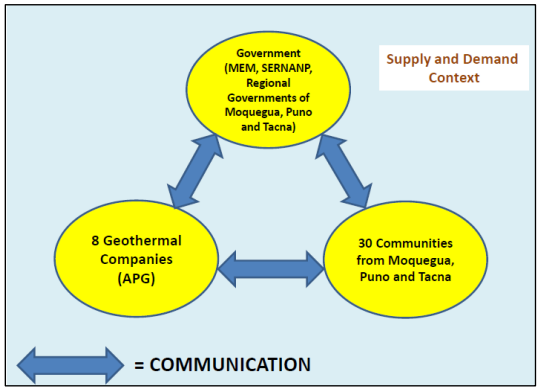


Figure 9 - Key Participants of the Communication Effort in Peru 2010-2013.

After several coordination meetings between these three groups and, as a pilot initiative, it was decided to call together representatives from the regional governments of Moquegua, Puno and Tacna. From each region, representatives from the mining and energy and economic development bureaus were invited via their respective regional president to attend a coordination meeting in Lima at INGEMMET offices on May 2011. Of special importance for this meeting was the participation of high-level officials from DGE and INGEMMET. Directors and sub directors of the regional bureaus came together with representatives of the geothermal companies who also participated at the May 2011 meeting (Figure 10).

The exchange was very positive. Experts from INGEMMET presented some of the strategic reasons why the country was interested in geothermal, the country's potential and the main characteristics of geothermal development, in addition to the advantages and limitations of these types of developments. Officials from the DGE presented the regulatory framework for geothermal development in Peru. The representatives from the regional governments in turn presented their opinions, uncertainties and expectations (Figure 10).

Figure 10 - Government officials from MEM's INGEMMET and DGE; representatives from the regional governments of Moquegua, Puno, Tacna; and representatives from the geothermal companies (May 2011).

The group agreed on developing "itinerant" workshops where representatives from the communities in the jurisdiction of the prospective geothermal areas, representatives from the geothermal companies, and representatives from the national, regional and local levels of government, could meet to learn and discuss geothermal development and the possible actions for making this a successful initiative.

IV. 2. Some Results

IV. 2. 1. Information/Knowledge Exchange Workshops

During 2011 three regional itinerant workshops were programed and developed in Tarata (Tacna Region), Carumas (Moquegua Region) and Putinas (Puno Region). During these encounters over 150 representatives and local authorities from 30 communities listened to the presentations by government experts and expressed their concerns, and proposed some actions that could be carried out to facilitate geothermal development (Figure 11).

The first itinerant workshops laid the foundation for more encounters and interactions at the regional, district, municipal and community level. The regional governments of Moquegua, Puno and Tacna often, in coordination with INGEMMET and DGE, organized several information exchange events engaging district, municipal, local authorities and community leaders. By 2013 the Arequipa Region had benefited from information efforts lead by INGEMMET. Representatives from this region also participated in geothermal information exchange events like the one coordinated by Moquegua's regional government in May 2013 (Figure 12).

Figure 11 - Aspect of the geothermal itinerant workshop in Putinas (Puno Region, 2011).

Figure 12 - Workshop on geothermal development organized by Moquegua's Regional Government. Moquegua, Peru, May 2013.

Institutional exchange workshops were articulated with community outreach activities carried out by several geothermal companies. The information obtained during these exchange activities helped some companies in the identification and mapping of stakeholders, and the acquisition of important cultural, social and economic data that could facilitate the engagement of communities and local authorities.

IV. 2. 2. Design and Distribution of Information Materials

One of the results of these workshops was the design and distribution of geothermal information material "with, by and for" the potential beneficiaries/participants/users of the geothermal initiative (Figure 13). In addition to the main message (e.g., clean, renewable and sustainable form of energy) the information instrument explicitly indicated the entities involved in its design and production i.e., the names of the institution involved and, around the borders of the poster, the names of the communities or community representatives involved (Figure 13).

With each workshop, participants could change aspects of the message and the design. Each new version was delivered back to the responsible group for distribution. This approach proved to be beneficial since it elevated the level of relevance of the information presented in the process, and the level of community engagement and participation.

Figure 13 - Information material about geothermal designed and distributed with, by and for the participants of the itinerant workshops (Peru, 2011).

IV. 2. 3. Community Engagement

Some of the exchange events took place in areas affected by socio-political conflicts associated with resource development such as mining, energy and water management. Often communities expressed their frustration that despite tremendous profits realized by mining companies operating in their midst, the lives of local people had not improved. On several occasions, local communities blocked mining projects that they feared contaminated local land and water sources. Communities like the Aymaras, especially in the Puno Region, have opposed the presence of foreign companies, particularly mining companies.

With no previous information about the geothermal industry, many communities were concerned about outcomes similar to previous conflictive experiences with the mining industry. On several occasions, geothermal reconnaissance groups from the government and private companies were warned not to access their land before explaining the project and before obtaining the respective access permits. In some cases, the opposition was total; people even would not know about the project and refused to provide access to their lands.

The itinerant geothermal workshops facilitated community leaders and authorities to engage. These workshops facilitated providing and exchanging knowledge and ideas, and together moving toward a common understanding and eventual acceptance of the geothermal initiative. The incorporation of the communities early in the process, in articulation with the different levels of government and geothermal companies, facilitated the engagement process.

During the knowledge exchange encounters, local authorities and communities had the opportunity to express their concern with respect to the possible environmental impacts associated with geothermal development. Of special concern was the issue of water usage and management. Likewise, technical people from the government and the private sector also had the opportunity to present, using the communities and authorities own language (Aymara, Quechua and Spanish) the characteristics, positive and negative, associated with geothermal development. One of the most outstanding results of these efforts was the fact that several companies working at that time in the Moquegua, Puno and Tacna regions obtained written community authorizations to carry out the initial phase of geothermal exploration (surface studies). On many occasions, members of the community were involved in data acquisition activities and logistic support services (Figure 14).

Figure 14 - Technical personnel and community workers before leaving for geothermal exploration field work. (Huaitire, Tacna, Peru; September 12, 2013).

IV. 2. 4. The Creation of the Peruvian Geothermal Association (APG)

The communication and information dissemination and exchange work by the geothermal companies was one of the bases for the creation of the Peruvian Geothermal Association (APG) in July 2012. Representatives from Andes Power, Ecoenergy, Enel Green Power, Hot Rock, and Alterra Power Corp. / Magma Energía Geotérmica Perú signed as the first official members of the APG. The APG was created with the purpose of establishing a proactive, non-profit group to provide a leadership role in geothermal development. APG constituted all the market players and stakeholders of Peru's geothermal industry in promoting industrial, scientific and educational activities in an articulated fashion with governmental and non-governmental, national and international bodies or others determined by the assembly, all for the benefit of the Peruvian society.

During 2012 and 2013, several geothermal companies underwent reorganization, reconfiguring the investors map in Peru. The Philippine based Energy Development Corporation (EDC) signed Joint Venture agreements with Hot Rock Limited (2012) and Alterra Power Corp. (2013) for the development of projects in Chile and Peru (Thinkgeoenergy, 2012, 2013). Under these new circumstance actors that previously had a key participation within the APG left, sending the organization into a hiatus.

During its existence the APG with the companies it represented, accomplished the objectives for which it was created. Its impact was perceptible in the successful articulation efforts with government officials from the national, regional and local levels and community representatives from different jurisdictions. The articulation effort led to important divulgation and knowledge exchange activities proposed and developed by different stakeholders. The work of APG was also instrumental in the modification and partial updating of the geothermal regulations that led to the promulgation of the Decree No. 015-2013-EM in May 2013. This decree linked the time allowed for exploration phases to the granting of the respective environmental instrument. But more importantly, the APG work contributed to the increasing understanding in communities and by authorities of the value of geothermal energy. In many cases the work contributed to change previous negative perceptions about the geothermal industry, facilitating the granting of exploration permits, and hopefully in the future obtaining support for geothermal development.

The continuation of the APG is important for Peru's geothermal industry. Its nature, character and objectives should adapt to the continuous changing conditions of the context where geothermal development takes place. Two of the most important geothermal companies in the world (EDC and Enel Green Power) are now active, applying their extensive knowledge and experience to geothermal development in Peru. Independently of contextual changes, the APG can continue to be a very important tool for geothermal promotion, information, knowledge and experience exchange.

IV. 2. 5. Establishing Compatibility between Natural Reserve Zones and Geothermal Development

With the communication/information activities on their way, the APG focused its efforts on solving the issue of the coexistence between natural reserve zones and geothermal development. The selected target area was the Regional Conservation Zone Vilacota-Maure in the jurisdiction of Tacna's Regional Government, where the majority of the most attractive geothermal prospects is located.

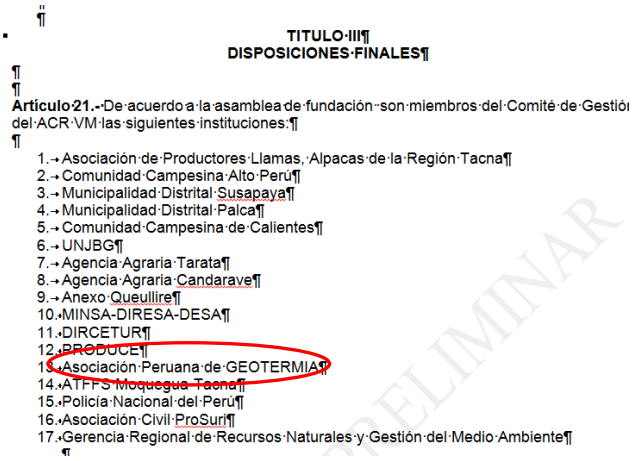
As a consequence of the lack of coordination between entities in charge of the environmental aspects of geothermal development and lack of geothermal knowledge, preliminary requests for exploration authorizations in this conservation area were rejected by MEM, due to the lack of approval from SERNANP. The APG established contact with Tacna's Regional Government Natural Resources Bureau (GRRNN) to explain aspects of the geothermal initiative. After this initial contact, the Protected Areas National Service (SERNANP) was contacted via

the NGO Protected Areas Promotion Fund (PROFONAMPE). With the institutional support of INGEMMET, representatives from these entities met in Lima (Figure 15) to discuss details of geothermal development, Peru's interest in developing geothermal and some of the environmental considerations to be taken into account for geothermal development.

Figure 15 - Representatives from the APG, INGEMMET, SERNANP and Tacna's Regional Government (Natural Resources, Mines and Energy, and Economic bureaus) met at PROFONAMPE to discuss compatibility between geothermal development and Natural Reserve zones (Lima, 2012).

One of the positive results of this activity was the invitation that APG received by the GRRNN to participate in the Vilacota-Maure Reserve Zone Management Committee in Tacna. This invitation was very important since it gave APG the opportunity to present the geothermal initiative in front of important local community leaders and authorities. During this meeting, the participants agreed to accept the APG as one of the members of the steering committee (Figure 16). As part of the steering committee APG could have the opportunity (from the inside) to explain and assist in the understanding of the geothermal initiatives to those communities in the jurisdiction of the Vilacota-Maure reserve zone. On the other hand, the APG has gained an increased opportunity to understand the environmental values and issues of the Vilacota-Maure Reserve, to steer geothermal development in effective synergy with conservation of natural resources in the area.

The institutional articulation around the compatibility issue for geothermal development in natural reserves zones has contributed to clarifying the process of obtaining the environmental instruments that will allow exploration and eventually geothermal development in natural reserves zones.



TITULO·III¶
DISPOSICIONES·FINALES¶

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Artículo·21.-·De·acuerdo·a·la·asamblea·de·fundación··son·miembros·del·Comité·de·Gestió
del·ACR·VM·las·siguientes·instituciones:¶
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1.→Asociación·de·Productores·Llamas,·Alpacas·de·la·Región·Tacna¶
2.→Comunidad·Campesina·Alto·Perú¶
3.→Municipalidad·Distrital·Susapaya¶
4.→Municipalidad·Distrital·Palca¶
5.→Comunidad·Campesina·de·Calientes¶
6.→UNJBG¶
7.→Agencia·Agraria·Tarata¶
8.→Agencia·Agraria·Candarave¶
9.→Anexo·Queullire¶
10.·MINSA-DIRESA-DESA¶
11.·DIRCETUR¶
12.·PRODUCE¶
13.·Asociación·Peruana·de·GEOTERMIA¶
14.·ATFFS·Moquegua·Tacna¶
15.·Policía·Nacional·del·Perú¶
16.·Asociación·Civil·ProSuri¶
17.·Gerencia·Regional·de·Recursos·Naturales·y·Gestión·del·Medio·Ambiente¶
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Figure 16 - The Peruvian Geothermal Association (APG) is accepted as member of the steering committee of the Vilacota-Maure Reserve Zone Management Committee (Gerencia Regional de Recursos Naturales y Gestion del Medio Ambiente. Tacna's Regional Government. 2012).

IV. 2. 6. Review and Update of Geothermal Regulations

Gaps and ambiguities in the regulations have an effect on the geothermal activities authorization process. Between 2011 and 2013 several geothermal companies experienced delays related to the granting of the environmental instruments needed to start exploration activities. Specifically, the 2010 geothermal regulation indicated (Article 12, numeral 12.6) that an environmental study was required before starting any exploration work. The MEM's Directorate General of Energy-related Environmental Affairs (DGAAEE) is the entity responsible for providing the environmental guidelines and instruments needed for exploration work. This entity is also responsible for determining the need (or not) for the environmental instrument depending on the characteristics of each exploration work plan. According to the geothermal regulations, the approved time duration for Phase I exploration (surface studies) is two years and for Phase II (exploratory drilling) one year. However, the DGAAEE needed time to evaluate each particular situation. The problem was that the time the DGAAEE was taking for evaluating each of the authorization cases, was reducing the actual time the regulations approved for each of the exploration phases. Because of this situation several companies saw their authorization areas fall to default when the time for Phase I exploration activities expired while waiting for the granting of the respective environmental instrument.

Foreseeing this situation, in 2011 the geothermal companies, as part of the ongoing communication/articulation effort, and thanks to the good disposition of MEM's officials, started working together on reviewing the regulations. Legal teams from several geothermal companies shared and exchanged their expert opinions with MEM's legal advisors. Representatives of the geothermal companies (including diplomatic representatives from Australia and Canada) held numerous meetings with authorities from different sectors and levels of government. Regional presidents, congressmen, the Minister and Vice minister of Energy and directors and managers from important organizations were contacted seeking support for updating of the regulations.

The effort paid off with the release on May 24th 2013 of a modification of the geothermal bylaw through the Supreme Decree No. 015-2013-EM. This amendment modified Article 7 setting the exploration times (Phase I = 2 years; Phase II = 1 year) to start after the granting of the respective environmental instrument. With the new regulation in place all the areas previously in default, regained their legal status.

V. CONCLUSIONS AND RECOMMENDATIONS

Peru's energy demands derivate from a remarkable economic growth. Peru, with its strategically located abundant geothermal resources and the need for water conservation has the opportunity to facilitate geothermal development and become a world leader in use of this clean energy source. Many of the most attractive geothermal resources occur in areas where there are important mining resources and where water is not abundant. Geothermal developments with their relatively low water use could contribute to solve the social tensions derived from the relationship between resource development/utilization and water conservation.

Geothermal development is shaped by factors such as geothermal and social context knowledge; political and policy framework; regulatory framework and; infrastructure and implementation support. All of these factors constitute a cycle in which each of them interact informing each other on the path to action: the development of the geothermal industry in Peru.

More detailed exploration studies are needed to reduce high levels of uncertainty regarding the actual geothermal reserves. It is recommended that there be a higher degree of government commitment and involvement, possibly even co-participating with financial and human resources in the detailed and exhaustive evaluation and de-risking of geothermal resources.

To advance geothermal, a politically favorable environment is needed. Political stances shape the writing of policies that facilitate action. Decision-making is intrinsically related to the exercise of politics, and knowledge is the basis for informed decision-making processes. Political favorability is based on clear, pertinent and rigorous information and knowledge (technical, cultural, social, and economic, etc.). For this reason, stakeholders must have a basic understanding of what geothermal development is about, including its affinity with the Andean people's beliefs and the socio-economic and environmental benefits this industry can bring. However, the geothermal industry must also know more about the context in which it operates. Information and knowledge is very important for the creation of processes and platforms where the participants of the geothermal initiative (stakeholders and shareholders) exchange the information, knowledge and resources that shape the course of geothermal development.

The regulatory framework in Peru has prolific laws and regulations that promote renewable energies including geothermal. Because of their different purposes and jurisdictions, many institutions are in charge of promulgating and enforcing these laws and regulations. The continuous adjustment of the regulations and the articulation between the different laws from the different sectors is critical to opening up the industry and moving forward.

For the geothermal industry to be successful, Peru needs to build a critical mass of stable, highly qualified personnel, state of the art research/processing equipment, and financial resources capable of leading the stakeholders' articulation process; generating, communicating, delivering and applying high quality, pertinent and rigorous geothermal - related knowledge (e.g., geoscience, engineering, social). It is also important for the government to offer a "place" where all the geothermal efforts can be traced, reviewed and articulated. A Geothermal Data Base should contain and be accessible to geoscience, engineering, cultural and socio-economic information. Geothermal data base is an instrument for geothermal information dissemination, exchange, education and implementation.

Given the high level of uncertainty, especially in the early stages of a geothermal project when the actual magnitude and quality of the geothermal resource have not been determined, obtaining funds has proved to be a very difficult task. It has become more evident the need for public – private associations for geothermal

development. To address this situation, there has recently been a surge of initiatives coming from multilateral banks and organisms aiming to apply the so called “risk mitigation funds” as an effort to reduce the uncertainty associated with the assessment and definition of the potential geothermal resources. The danger though, would be to assume that these types of actions “per se”, applied in isolated fashion, will solve the obstacles that difficult the current geothermal development in Peru. Without the adequate background knowledge, the positive political support, clear regulations, and the adequate infrastructure for implementation; proposals like these will not achieve the expected success. Multilateral institutions could play a very important role promoting and supporting initiatives that aim to the strengthening of the country’s capability for compiling, generating, informing, communicating and applying the geothermal knowledge.

There are three concepts that should be considered for strengthening the current geothermal development process in Peru: 1) The consideration of a supply and demand perspective; 2) The identification and articulation of key players in the geothermal development process and; 3) Understanding the role of communication.

The geothermal industry can offer services like electric power, heating and recreation that can bring, especially to the areas located in the jurisdiction of geothermal resources, social, economic and environmental benefits. In the supply and demand context there are several entities or groups of individuals that interact representing different interests, playing different social roles and functions. Communities, government and geothermal companies are key stakeholders for geothermal development. The geothermal industry in Peru need to reach that point where the effective and sustainable use of the available resources (heat, vapor, electricity, financial) can satisfy the socio-economic and environmental expectations and demands of the stakeholders of the geothermal industry.

Communication plays an important role in the establishment of constitutive relationships that shape the articulation of the different players or agents of the development of the geothermal industry. Communication facilitates the articulation and integration of the different experiences, knowledge, resources and initiatives of the agents/stakeholders involved. Together, the voices of supply and demand, represented by the different stakeholders, identify points of intersection, prioritizing geothermal development, identifying the issues to address, designing the agendas for action, and creating the social dimension to the geothermal industry value proposition.

There have been communication/articulation efforts lead by the geothermal companies that have been echoed by Peruvian government entities from different sectors and jurisdictions. Some of the most remarkable results are the realization of knowledge/experience exchange workshops at a national, regional and local level. During these events, representatives from different levels of government, communities and geothermal companies together, have expressed their interests, goals and concerns, generating and distributing geothermal information materials. These activities have facilitated community leaders and authorities to engage, acting together toward the common understanding and eventual acceptance of the geothermal initiative. Communities that not long ago rejected the possibility of geothermal development now welcome the geothermal initiative. Issues like the compatibility between geothermal development and natural reserve zones and the review of the geothermal regulations have been discussed and resolved out this articulation/communication approach. All these are however only an initial part of a process that must be continued, stimulated and improved.

Natural resource extraction and exports will continue fueling Peru’s socio-economic development. With it, the demand for electricity and water will continue to grow. Geothermal energy offers an alternative that together with other clean and renewable sources of power generation (such as solar and wind) can substantially contribute to the sustainable development that Peru requires.

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