

# Understanding social acceptance of geothermal energy: Case study for Araucanía region, Chile

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## ABSTRACT

This research aims to explore public views and social attitudes toward the use of geothermal energy as a heating and electricity source in an area where the geothermal energy production technology has yet to be widely introduced. This case study focuses on the community that surrounds the Villarrica Volcano in the Araucanía region of Chile. This area is considered to be one of the six high enthalpy geothermal zones in the Chilean Andes with the highest potential for geothermal energy production but actual production is nearly non-existent. Taking a risk communication approach, this research includes in-depth semi-structured interviews with local stakeholders. It suggests that there is a low level of understanding of the technology involved in geothermal energy production, and it highlights social barriers such as lack of trust, spiritual relationship to volcanoes, and uncertainty about environmental impact as factors that affect risk and public perception.

## 1. Introduction

The energy industry in Chile is at a crossroad. On the one hand, there is an urgency to adopt the use of renewable energy sources due to the country's high dependency on oil imports and to the severe droughts that have affected Chile for the last seven years (CR2 report, 2015). On the other hand, there has been an increase in resistance movements, which highlight the social dimensions of energy technology and production, and the challenges of integrating national energy needs with the interests of local communities.

Following the global trend to diversify energy sources, Chile has invested in promoting renewable energy use. Solar power is the most commonly known and socially acceptable option worldwide (Gross, 2012). Meanwhile, geothermal energy is a lesser known option. Chile is an Andean country located along the Ring of Fire and has high geothermal potential, with an estimated capacity ranging between 3000 and 16,000 Mwe (I.E.A.C., 2009; Lahsen, 1986). While countries such as Costa Rica and Mexico utilize geothermal energy for electricity production – with an installed capacity of 207 Mwe and 1017 MWe, respectively (Bertani, 2015) – this kind of energy is still not well developed and not well known in Chile.

In this context, this research aims to examine levels of understanding, public perceptions and describe general attitudes toward geothermal energy. This work is a first approach to understanding what

factors affect the level of social acceptance of this resource in the country. Social acceptance is a crucial factor in the development of any energy project (Cataldi, 1999) and there is a limited empirical evidence of how this kind of energy is perceived in Latin American countries like Chile. This research focuses on the Araucanía region in Chile, particularly on the communities that surround the Villarrica Volcano. This region has more than eight volcanoes and around 20 hot springs that are used for recreational activities. The Villarrica Volcano is one of the most active volcanoes on the continent (Lara and Clavero, 2004; Stern, 2004). Araucanía is also home to 33% of the total Mapuche population in the country.<sup>1</sup>

### 1.1. Geothermal energy in Chile

Geothermal energy is one of the least known energy sources in Chile, even though the country's geological characteristics make it an exceptional place for such energy development. Despite the fact that geothermal geologic exploration started in the 1920s (Tocchi and Tatio, 1923) and that the Chilean Geothermal Law 19,657 was enacted 16 years ago, high enthalpy geothermal production remains almost non-existent (Bertani, 2015).

There are several factors that have contributed to the paradox of Chile being a country with high geothermal potential but – as of yet – no great geothermal energy production. Saldivia (2012) argues that the

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<sup>1</sup> The Indigenous Law 19.253 recognizes the existence of nine indigenous groups in Chile. They are Mapuche, the Aymara, the Rapa Nui, the Atacameños, the Quechua, the Colla, the Diaguita, the Kawashkar and the Yagán. (Molina, 2012)

main barriers to developing high enthalpy projects in Chile are economic, legal, and institutional. He includes slow processing times for bids related to geothermal projects, short time frames for exploration, lack of public funds during the exploration stage, and lack of geothermal specialists working at relevant ministries and other institutions that deal with energy production. The scenario becomes even more complex if other factors – such as the lack of medium and long-term energy policies, and the absence of energy-related government initiatives – are included in the equation (Sanchez-Alfaro et al., 2015).

From a high enthalpy point of view, the Chilean geothermal concession market peaked in 2012 with 76 exploration concessions. However, the number decreased to 43 in 2016 (Sernageomin, 2017). The first Chilean geothermal plant – located at Cerro Pabellón in the Antofagasta region – was started March, 2017. The plant is operated by ENEL Latin American (Chile) and by Chile's National Oil Company (ENAP), and is expected to have an installed capacity of 48 MWe (ENEL, 2012). Low enthalpy geothermal production, on the other hand, has been met with less opposition in Chile but is still precarious. There is no national registry of geothermal direct use projects, but available data suggest a 19.91 MWt installed thermal capacity (Lund and Boyd, 2015). This energy has been mostly used for recreational purposes, specifically spas and swimming pools. Other direct use projects include the heating of the Voipir Ñancul public school in the city of Villarrica – which is heated by two geothermal heat pumps – and a public hospital in Talca, Maule region.

The 2009 El Tatio well blow out incident drew mass media attention and negatively affected the perception of geothermal energy, transforming it from an unknown energy source to an infamous one (Otero, 2015). An abrupt, strong steam discharge took place in a well at El Tatio field, which is an area with great geothermal potential, but is also an important tourist attraction located on indigenous territory. This discharge lasted for 27 days, reaching 60 m high. The Chilean Ministry of Environment requested an international assessment on possible effects to the geysers, the research was in charge of United Nations Development Programme (PNUD). The report pointed out that the geysers were not affected by the incident but that the situation could have been prevented. The report also highlighted an information gap among the company and local community. Since then, geothermal energy has gained some opposition among the general population in Chile. As Hornig (1993) points out, public attention is influenced by media attention, and media coverage shapes perceptions and opinions.

### 1.2. Social acceptance and risk communication

In the global renewable energy sector, social acceptance has been identified as one of the most powerful barriers to the implementation of new technologies (Cataldi, 1999; Wüstenhagen et al., 2007). Although in the literature there is not consensus about the definition of “acceptance” and it could be discussed from different disciplines, this research focus on local acceptance which implies an active or passive support from stakeholders (Wüstenhagen et al., 2007) and including opinions, actions and decisions. The definition of social acceptance as shifted from a market orientation to a socio-political approach (Fast, 2013). Conceptually, social acceptance has three dimensions: a) social-political, understood as the acceptance of the technology by stakeholders, the public, and policymakers; b) community, which relates to procedural justice and trust among stakeholders; and c) market, which refers to the relationship between consumers, investors, and firms (Hornig, 1993). Walker and Cass (2007) highlight ‘the public’, as a key stakeholder. They argue that this group has been historically simplified – reduced to simply protestors and supporters. Walker and Cass, however, offer a broader definition of the term which takes into account ten categories of ‘the public’: consumer, service user, financial investor, local beneficiary, technology host, energy producer, project participant, protestors, and supporters.

Generally, geothermal energy does not have a high level of social

acceptance like other kinds of renewable energy such as solar or wind (Popovski, 2003), and it has not played a significant role in public debates on renewable energy (Gross, 2012). Several studies have found that some of the main factors affecting geothermal acceptance include: limited public knowledge about the technology, unfavourable media coverage, concerns such as water use and seismic activity (Dowd et al., 2011), uncertainty about the reversibility and predictability of adverse effects on hot springs (Kubota et al., 2013), and low levels of community participation in consultation processes and project development (Carr-Cornish and Romanach, 2014).

Because public uncertainty and gaps of information affect the social acceptance of an energy technology, taking a risk communication approach that encourages active dialogue among stakeholders can offer fertile ground to undertake an empirical exploration about social attitudes toward geothermal energy. First of all, communication, as a symbolic action, can shape public opinion and perception as tool for negotiation. The concept of risk communication has not had long-standing use and can be read in different lights (McComas, 2006), however, this research adopts a democratic conceptualization. Risk communication is defined as an network, or interactive exchange of information among individuals, groups, and institutions (Carr-Cornish and Romanach, 2014; Grabill and Simmons, 1998) which “promotes a fair process, where the goal is mutual understanding among the interested parties and two-way exchanges takes place (McComas, 2006; Palenchar and Heath, 2007). Effective risk communication planning allows trust to build among stakeholders, enabling all involved parties to make well-informed decisions, and, therefore, empowers local communities (Fast, 2013; Scherer and Juanillo, 1989). This approach is proper to analyze a broad societal energy discussion because information and education practices takes place in an uncertain context (Corvello, 1988). Risk is also a complex concept. In this research, risk is not limited to physical assessment ‘but are also a reflection of the understanding of the social system and the actors playing roles within them’ (p.3), where context local beliefs, attitudes and values affect the interpretation of risk communication messages (Eriksen and Prior, 2011).

### 1.3. Villarrica, selecting the study area

This study took place in Villarrica, a city 746 km south of Santiago. Located in the Araucanía region, the natural landscape is one of its main attractions and includes 12 protected areas that extend over 291,784 ha. The city also encompasses the iconic Villarrica volcano (39° 25' S; 71° 56' W), a composite stratovolcano that is one of the most active volcanoes in the Southern Andes (Lara and Clavero, 2004; Stern, 2004). From a geological perspective, the Araucanía region is one of the six high enthalpy geothermal areas in the Chilean Andes with the greatest potential for production (Aravena et al., 2016). The city's total population nears 50,000 inhabitants, and there are numerous Mapuche indigenous communities in the surrounding area.

From a social and cultural perspective, this region is marked by a complex relationship between the state and indigenous communities. When the Spanish colonizers first settled the area in the 16th century, they founded Villarrica on Mapuche territory. Since then, indigenous resistance groups have fought for political autonomy, land restitution, and the recognition of customary rights.

In this socially and environmentally complex scenario, the relationship between the state, energy companies, and local communities is also tense. In 2015, nine wind energy, 20 hydroelectric, four bio-energy projects, and one exploration geothermal project were carried out in the region (ME report, 2015). Energy projects, in particular, have caused significant disagreement between local communities and the state. In 2015, at least nine socio-environmental conflicts took place in this area (INDH, 2015).

Two geothermal projects drew the attention of the local community in the Araucanía region. The first one started in 2009 in the small town

of Melipeuco (around 100 km from Villarrica), where a geothermal exploration was approved. The second project took place in 2012, when a geothermal exploration led by GeoGlobal Energy started at the top of Tolhuaca volcano (180 km from Villarrica). Mighty River Power, the company which took over lead of the exploration, halted the Tolhuaca project and announced the sale of the company's shares in the project (Sanchez-Alfaro et al., 2015). Mighty River Power cited the “complexity of project financing, accounting and tax and governance time” as reasons for terminating the project (Whineray and Meek, 2015). Currently there is one active exploration concession, in the Araucania region. Belonging to Transmark Chile Spa, the El Valle concession is located in Pucon and Curarrehue municipalities (MinEnergia, 2017). Araucania region also has experience with using geothermal energy directly. In addition to the heating system of the public school mentioned earlier, there is a private 34-house condominium that also uses geothermal energy for heating (CCHC, 2014).

## 2. Methodology

This case study aims to examine local attitude towards geothermal development and identify factors that influence them.

The research project employed a qualitative approach using a single case study design. Case studies are suitable for analyzing complex social phenomena as they allow the establishment of linkages between practical events and theoretical abstractions (Stake, 2005) and they have a powerful advantage in the identification of new variables (George and Bennett, 2005). Data collection began with a literature and press review, which identified hot spring managers, non-indigenous members of the local community, local government officials, and Mapuche community members as key stakeholders. In addition, this research included interviews with national officials and consultants who were directly involved in geothermal energy projects in the Araucanía region.

In-depth semi-structured interviews (26) were conducted with individuals belonging to the categories identified above. Guest et al. (2013) point out that semi-structured interviews are appropriate tools for gathering information from an individual perspective, or focusing on individual experiences, beliefs, and perceptions (Guest et al., 2013). The goal of the interview was to comprehend participants' opinions and attitude toward geothermal development in order to have a broader understanding of social barriers to geothermal projects in Araucania territory. Participant groups were initially chosen by reviewing press coverage to identify relevant stakeholders, and the goal was to include a wide range of perspectives. All participants signed written informed consent agreements. Interview topics included: level of understanding about geothermal technology and its different uses, information access, level of trust among stakeholders, communication strategies, and level of involvement in energy projects, information sources, and relationship with volcanoes.<sup>2</sup> All of the interviews were carried out from June to September 2016.

All of the information gathered through the interviews was thematically analyzed to identify different types of stakeholder attitudes and factors. Atlas-TI software was used to thematically organize the information.

The interviews included:

1. 5 hot spring managers: The spas are located in Villarrica and Pucón municipalities. Two large and 3 small hot spring spas were included.
2. 5 Mapuche community members: All 5 participants lived in a rural

area near Villarrica Volcano

3. 6 non-indigenous community members: They live in an urban area in Villarrica Municipality
4. 5 local officials: These participants work in Villarrica municipality and in the regional offices located in Temuco. The institutions include environmental, local development, tourism and social development.
5. 5 consultants/government officials: They work in the regional offices located in Villarrica, Temuco, and Santiago. The group comprised one geologist, two social communicators, one forestry engineer, and one mining engineer. The institutions involved include geology, indigenous and social development.

## 3. Results: stakeholder analysis overview

This research supports the global trend of a generally limited knowledge and understanding of geothermal energy among the general public (Cataldi, 1999; Carr-Cornish and Romanach, 2014). Although the majority of participants have low levels of knowledge about geothermal electricity and heat production, they hold intuitive understanding and have formed opinions on geothermal development. In general, a negative social attitude was predominant among local community members and hot spring managers, while local officials and energy consultants were more open to geothermal electricity generation. In this matter, several participants acknowledge that their attitude to geothermal industry is influenced by the general opinion about energy project in the region.

The following sections provide an overview of the main factors that explain the attitude toward geothermal energy among the interviewees. The first part discusses the level of understanding of geothermal technology, regardless of the participants' role or position. The second part breaks down each stakeholder, to better understand the root of their respective attitude toward geothermal energy.

### 3.1. Low level of understanding and linear communication process

Hot spring managers and local officials, who have moderate level of familiarity with geothermal energy uses and impacts, were more receptive to use the resource. However, the majority of participants acknowledge that they have a low level of understanding of geothermal technology. The majority associate geothermal resources to hot springs, but the industrial use of geothermal energy such as heating buildings or greenhouses was not well understood. An officer from the local municipality mentioned that “if [they], professionals who work in energy field, do not know how geothermal energy works, it is difficult to promote local policies” (interview with local official, author's translation from Spanish).

According to the analysis, the lack of access to key information about geothermal energy, such as successful examples of direct use and graphic material about how geothermal plant work, affect social attitudes. The following comment made by a hot spring manager illustrates this point: “This type of energy is not intuitive, like solar or wind energy. We have not seen how this energy works, so it is difficult to imagine how the heat can be extracted from the earth without damaging the environment and the underground water resource” (author's translation from Spanish).

On the other hand, participants from local communities indicated that they have not been involved in any decision-making processes related to an energy project to date, including but not limited to geothermal energy. They also claim that communications about such projects have been issued from the top-down; in other words, “companies start communications when projects are already approved or even years later,” as a local non-indigenous community member said (author's translation from Spanish). In a similar vein, a Mapuche community member expressed that “[they] feel vulnerable as neighbours because energy companies approach the communities after months of working

<sup>2</sup> The questions included: a) What is your general appreciation regarding the use of geothermal energy in Araucania? b) How much do you know about the potential and development of geothermal projects? c) Do you know any local geothermal projects? d) Can you describe different uses of geothermal energy? e) How do you describe the communication and relationship between different actors involved in energy projects? f) What experiences have you had with energy projects in the area?

on [their] territories. At that time it is too late, because the trust is already broken” (author’s translation from Spanish). In spite of this situation, participants showed interest in knowing more about geothermal energy, especially about direct use.

Lack of community involvement risks causing not only rejection of energy projects in general, but also distrust regarding the information given by companies to the community. In this context, several local community members mentioned that they seek out information about such projects through social media and local media. Participants living in rural areas also made this point. They mentioned that “[they] are not waiting to receive information. We look for ways to get informed and the most common sources of information are Facebook or Twitter. Even though we do not have Internet access at home, we prefer to do it this way,” a Mapuche community member said (author’s translation from Spanish). Regarding this point, participants acknowledge local community leaders as reliable information sources. These leaders are generally *Lonkos*, the head of Mapuche communities, and young professionals, who promote environmental protection among the rural non-indigenous community.

Although in the region, Tolhuaca exploration concession took place in 2012, it was not mentioned much in the interviews. Several participants pointed out that they were not aware of the reasons of the ending of the project. However, local and national officials stated Mellipeuco concession as an event that had social impact, particularly among Mapuche community and local environmentalists.

### 3.2. Stakeholders’ Points of view

In order to better understand the roots of the attitudes toward geothermal energy among the stakeholders interviewed, the following section examines the most common factors mentioned by each group.

#### 3.2.1. Hot spring managers

**3.2.1.1. Uncertain adverse effects on hot springs.** According to the interviews, one of the most important factors affecting perceptions about geothermal energy production among hot spring managers concerns the uncertain effects on underground water resources. All interviewees share the concern that “if there is a geothermal plant, springs will probably be affected... [and they] will lose water quality,” as one hot spring manager stated (author’s translation from Spanish). For this reason, the relationships between hot spring managers and geothermal researchers are often tense. “It is common to close the door to scientists because [hot spring managers] are afraid of losing the resource,” one of the interviewees indicated.

#### 3.2.2. Government officials

**3.2.2.1. Impact on tourism.** The research findings suggest that one of the main concerns of local government officials is the potential negative effect of geothermal projects on tourism, given the uncertain environmental consequences and other impacts on sustainability. As one local official stated, in the Araucanía region, the main “concerns are biodiversity and nature... It is an area that depends heavily on the work of entrepreneurs in the tourism industry, which includes volcanoes. Nature is our wealth, our main resource, so if someone wants to make a project on this territory clearly there will be public disapproval” (author’s translation from Spanish).

The large size of geothermal concessions and their location are other points that have an impact on the perception of government officials. “Villarrica is the icon of the region, and there is local tourism around trekking routes, hot springs, and hotels that could be affected if the volcano is intervened, for instance,” a local official said (author’s translation from Spanish).

**3.2.2.2. Environmental decontamination.** Government officials acknowledged the potential environmental benefit of using renewable geothermal energy. There is considerable air pollution in the large urban areas due to wood burning as an energy source. “Local residents

could benefit by directly using geothermal energy, especially for the air pollution problem we face. We are burning the native forest to heat houses. However, there is a lack of awareness in this matter” a professional from local governmental institution argued (author’s translation from Spanish).

#### 3.2.3. Local community (non-indigenous and mapuche)

**3.2.3.1. Steam discharge at el tatio.** Several community members mentioned the geothermal exploration in El Tatio, which drew substantial media attention seven years ago due to a significant steam discharge. Participants pointed out that this event was the first time that they heard about geothermal energy and that it shaped their perceptions. They argued that the discharge could be seen as an expression of nature against the exploration and lack of energy company training, while at the same time as a possible harm to the environment as a result of the exploration. “This project was rejected by Aymara [indigenous] communities because of its environmental impacts. The discharge was a clear sign to stop,” a Mapuche participant stated (author’s translation from Spanish).

**3.2.3.2. Costs-Benefit relationship.** Two common questions that were raised by local community members were “What do we gain from this?” and “What are the benefits for us?”. These questions suggest that they perceive an inequality in the distribution of benefits regarding energy production in general.

The point seems crystal clear in the following comment made by one of the interviewees: “We have a hydroelectric plant, for example, in our territory. But we have only had electricity at home for the past 5 years and it is very expensive. So, why would we have to accept a geothermal energy project if we do not receive any benefits?” (author’s translation from Spanish).

The findings suggest that this issue goes beyond geothermal energy. The perception of unequal benefit distribution is the result of other regional experiences associated with different energy projects.

**3.2.3.3. Lack of trust.** Lack of trust among stakeholders was another key point identified by research participants. While this lack of trust was not limited to geothermal energy projects, it was a predominant answer among the interviewees.

From the perspective of the local community, this lack of trust is also the result of prior negative experiences related to energy projects. The following statement by a Mapuche community member illustrates the point: “Why do we have to trust energy companies? There is no reason to trust [them]. Distrust is historical and the companies’ practices do not cooperate to build a strong relationship – quite the contrary” (author’s translation from Spanish).

A very interesting finding is that both indigenous and non-indigenous community members see a relationship between geothermal energy and mining. Their argument is that “[they] see what has happened in mining cities in the North [of Chile]. The problem is not the resource itself, the issue is how the industry works to exploit underground resources” (interview with urban community member, author’s translation from Spanish). This situation presents a complex scenario for geothermal energy given the environmental impacts of the mining industry in the north of the country.

**3.2.3.4. Spiritual relationship to volcanoes.** Mapuche community members talked about the strong relationship between local community and volcanoes in particular. The Mapuche nation has a strong relationship with volcanoes and sees them as spiritual spaces. According to their traditional knowledge, humans should not disturb volcanoes. Therefore, the fact that geothermal energy projects might disrupt the natural environment creates a negative perception among Mapuche community members toward these kinds of developments. “We see the volcano as energy, but as spiritual energy, not as a resource to satisfy needs...The volcano is alive, so it is very complicated for us to

think about drilling it” (interview with a Mapuche community member, author’s translation from Spanish).

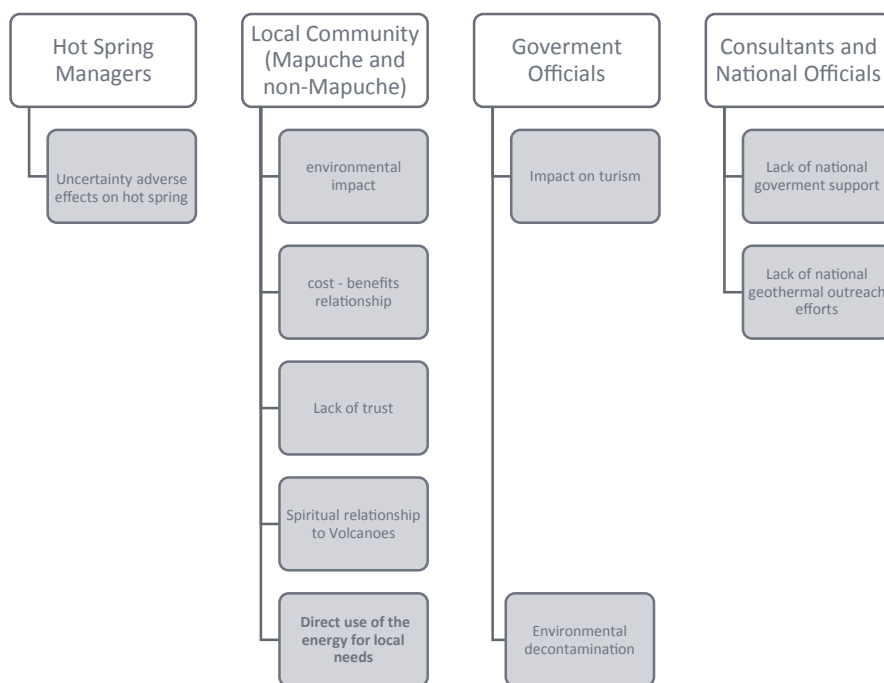
Most interviewees stated that even though they have not enough knowledge about this resource, they react negatively towards any geothermal initiative. For instance, one Mapuche community member said: “I do not know exactly how geothermal energy works, but any activity that involves changing elements of Mother Earth- such as volcanoes – is aggressive and invasive in my view” (author’s translation from Spanish).

**3.2.3.5. Direct use of the energy for local needs.** One benefit mentioned by local community member was the opportunities to use geothermal energy for local energy needs. Although the majority of participants did not know about specific uses, they express interest in knowing more about the matter. They were particularly interested in heating schools and greenhouses. “The situation changes when it comes to use the energy for local needs. La Araucanía, in general, requires heating at least six months of the year, so in that sense, it could be helpful, especially for rural schools”, mentioned a local community member.

**3.2.4. Consultants, and national government officials**

**3.2.4.1. Lack of national government support.** According to energy specialists and local consultants, one of the main factors behind the attitude toward geothermal energy is insufficient efforts regarding public engagement. They criticize the lack of educational projects and initiatives aimed to include local communities in energy projects, especially regarding the direct use of geothermal energy. “Although we have several volcanoes in the region, they are not seen as energy resources” a professional from local governmental institution argued (author’s translation from Spanish).

The most common factors mentioned above by each group are summarized in the following table.



**4. Conclusions**

This research project was conceived as an exercise to better understand the level of social support for geothermal energy projects in a region with great potential for high enthalpy geothermal energy production but no actual output (at the time of the interview). Overall, the findings indicate that participants have low levels of understanding and unfavourable opinions about geothermal energy for electricity production, which is a fairly consistent scenario across the globe (Cataldi, 1999; Popovski, 2003; Kubota et al., 2013; Carr-Cornish and Romanach, 2014). From these results, it is possible to infer both that there is a low level of social acceptance of the geothermal technology among the Villarrica community and that the risk perception is high. Future researches should undertake a quantitative approach in order to confirm this thesis.

Multiple factors contribute to social opposition to geothermal development projects. This research illustrates how perception changes among stakeholders (see Fig. 1). Although there is no consensus across the main concern, there is some connection among the factors highlighted. While for local officials, hot spring managers, and local community, the major concerns are possible secondary effects on tourism, hot spring and environment, respectively, however, they also showed interest in knowing more about direct use applications. In this sense, direct use of geothermal energy seems to be an opportunity to introduce the resource and improving social acceptance in this region. To promote space or greenhouse heating projects in isolated areas characterized by lack of thermal comfort due to adverse climate conditions such as Lonquimay and Mellipeuco or in high-contaminated urban cities such as Temuco in Araucania region could be an entry ticket to improve community acceptance. In this matter, Chile could learn from countries like New Zeland where direct use projects are in charge of Maori community (Richter, 2017).

At the same time, factors that might have influenced attitudes toward geothermal energy among local community, indigenous and non-

indigenous, are distrust among stakeholders and lack of citizen engagement in early stages of energy projects. Taking into account that the level of social acceptance is higher if the community participate in decision making process prior to the technology implementation (McComas et al., 2016; Besley, 2010), future research could focus on community public engagement strategies developed in Chile, specifically made by GeoGlobal Energy in Tolhuaca project and Enel Green Power and Enap in Cerro Pabellón Plant (most advance project in Chile up to date). Both geothermal projects reached different development stages, thus the analysis of those cases could be a great empirical explorations about different local participation strategies in two different indigenous territories.

From indigenous people point of view, this empirical research confirms the complexity of the relationship between human beings and the land (Marsden, 2003). The spiritual and historical identity of the Mapuche people is directly linked to their land. In Anderson's (1996, p. 179) words, "people interact with their surroundings... these surroundings become meaningful— not just as sources of food and shelter, but as sources of beauty, power, excitement... the meanings of nature are bound up in systems of respect and protection". In this context, in order to increase social acceptance of geothermal energy among the Mapuche, it is necessary to take this relationship into account. At the same time, this research highlights the need to extend efforts to promote energy culture among indigenous population. Information access about geothermal concessions and industry looks to be critical to start an equal conversation among stakeholders.

This research illustrates that some of the negative attitudes toward geothermal energy mentioned before are not limited to geothermal energy production. This research shows that there is a low level of support in general for any energy project in the Araucanía region, mainly due to prior experiences with energy companies and to the perception of negative environmental costs and lack of local benefits in general in the country. The results of this research suggest that future energy projects might be resisted by local stakeholders if they do not take into account variables described above such as the lack of trust, and spiritual and cultural relationship with territories and volcanoes.

Particularly interesting is the connection between geothermal energy and mining made by some participants, which seems to be one of the factors that affects the level of trust. Although Chilean geothermal concession law has similarities with mining law (Saldivia, 2012) and the geothermal legal framework was enacted in the Ministry of Mining in 2000, these facts were not mentioned by participants. The connection is made by the use of the subsoil and because some mining companies have geothermal concessions. One of the most relevant participants concern is the environmental impact related to subsoil use. Latin American research is not robust in this area mainly due to the absence of high enthalpy projects in the region, however, some explorations highlight how negative reputation of extractive industries affects social acceptance due to environmental degradation (Barton, 2015). This situation is common across Latin American countries characterized by promoting extractive industries (Van Campen et al., 2016). This insight is a starting point for future explorations in this area, which is a critical matter in mining countries such as Chile and Peru.

From a communication perspective, this case reflects that initiatives to promote geothermal energy made by governmental institutions and industry have not reached communities with great geothermal potential as Villarrica. This situation is relevant considering that two geothermal concessions had been approved in this region. This case encourages including bottom up communication strategies in energy projects and promoting macro-communication plans focusing in decision makers and local governments in order to increase the public understanding of geothermal energy. Acknowledging that social acceptance goes beyond to information access (Irwin, 2002), with this research it is possible to infer that the lack of knowledge of geothermal potential and its possible local benefits affect the general attitude toward this energy source.

Finally, these research insights offer possible lines of inquiry. Future

empirical research could contribute to a deeper understanding about how different public engagement strategies are carried out in Latin America and how they interact with stakeholders' positions. The social impact of geothermal energy debate has not been well developed in the local literature. Future research that is relevant to renewable energy expansion could include: role of mass and alternative media in environmental and geothermal local discourses, relationship between risk perceptions, level of social acceptance and public engagement, and; the integration of local knowledge in direct use of geothermal power, and taking into account that a reduced study area is one of this research limitations, future enquiry could include a broader territory in order to include other indigenous group, particularly in northern Chile where the landscape, culture and local practices are different from the South.

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