

# Geothermal Energy: Energy Alternative to Combat Frosts and Cold Spells in Perú



Diana Castillon Huayhua , Junior H. Nieto Lapa ,  
and Steve D. Camargo Hinostroza 

**Abstract** In recent years, frosts and cold spells have been more prolonged and have caused an increase in respiratory diseases, death of livestock, food shortages, and crop losses, especially in the high Andean areas. Therefore, this research was proposed to evaluate geothermal energy as an alternative to combat frosts and cold spells in Peru, this was done with information from ministries, important representative institutions, or attached to the above and scientific articles on the subject, taking into account the economic, social, and environmental. The results show that there is a high geothermal potential, concentrated in the south of our country, with an electrical generation capacity of 3000 megawatts. The Schumann and Quello Apacheta projects are currently the most advanced and will have an initial investment of more than US\$ 1000 million and an initial production of approximately 500 MW. The contributions that the use of geothermal energy will provide will be the generation of jobs, massive heating, cheap energy, zero emissions, it is not susceptible to meteorological changes, improves food conservation, and could add economic growth of 0.7–1.9% per year to the regions that host these geothermal power plants. Therefore, geothermal energy is a renewable natural resource due to the heat reserve stored inside the earth, where its efficiency, inexhaustibility, environmental friendliness, low cost, and durability make it a viable energy alternative to combat frosts and cold spells in Peru.

**Keywords** Geothermal energy · Frosts · Peru · Geothermal potential

## 1 Introduction

In the last two decades of this century, according to Rivera Delgado et al. (2021), the studies of energy transition and the role that innovation and technology play in the development of solutions energy and development of countries (mainly emerging economies) have claimed great importance in the research field of development, innovation systems, transitions to sustainability, and energy systems [1]. Hence, the

---

D. C. Huayhua (✉) · J. H. Nieto Lapa · S. D. Camargo Hinostroza  
Continental University, San Carlos, 1980 Huancayo, Peru  
e-mail: [75516910@continental.edu.pe](mailto:75516910@continental.edu.pe)

© The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd. 2023  
M. L. Kolhe (ed.), *Renewable Energy Systems and Sources*,  
[https://doi.org/10.1007/978-981-99-6290-7\\_5](https://doi.org/10.1007/978-981-99-6290-7_5)

energy demand is increasing in line with the increase in the consumption of goods and services, however, in the attempt to meet and satisfy these needs has led to overexploitation of fossil fuels for the production and distribution of these. As a result, concern has arisen about environmental care, because productive systems work with traditional energy resources and, given the limited ecological capacity we have, it is necessary to implement new clean energies. The earth possesses an enormous amount of these energetic resources (30 million Terawatts) [2], however, one of the bigger problems that faced humanity is the obtainment and transformation of these resources.

Energy is known for its indispensability for social, industrial, and economic development. Energy is the source that allows us to achieve high productivity values and economic growth, the industry currently uses large amounts of energy, mainly of the electrical type, therefore, industries require abundant energy, served at home, with adequate prices, which are safe, efficient, that do not run out and do not pollute the environment [3] and meeting these growing needs energy and protect the environment is one of the challenges facing the world; in our case, we have many different renewable sources, including geothermal [4].

On the other hand, in Peru, year after year, frosts and cold spells hit the high Andean areas of the country. CENEPRED estimates that, for this present year, more than 3.7 million hectares of crops (13% more than last year) are at risk of being exposed to low temperatures, and a few 550 districts in 17 regions of the country in high risk and very large of exposure in July and August. The largest number of hectares threatened itself find in the regions of Puno, Ayacucho, Arequipa and the great number of crops threatened them two first together with Ancash [5]. In addition, it is added that there are more than 7 million Peruvians, 663 thousand of whom live in the group of persons of very high risk and more than 6.5 million people are in the group high risk under the influence of the low temperatures, where influenza and pneumococcal is principals diseases more frequent and is vaccinations have not exceeded 30% [6], whatever thus increasing the vulnerability and risk of contracting respiratory diseases.

According to Rumbo Minero, (2020), geothermal energy is a cleaner alternative for ensuring sustainable electricity supply. Since geothermal energy uses steam that resides of the way naturally below the earth and then re-inject it after use, this generates a closed and sustainable cycle of electricity production. The world's first geothermal power plant began operating in 1913 and today, more than 100 years later, is still producing power. Well-managed, a geothermal reservoir could be inexhaustible [7].

For all the above mentioned, Peña Jumpa, (2014) frosts and friajes are common phenomena during the winter in the Peruvian Andes, causing the death of thousands of animals, destruction of homes, damage to health and family economy of people, which leads us to reflect on the need for the right to heating [8]. Therefore, this research aims to describe geothermal energy as an energy alternative to combat the frosts and cold that year after year hit our high Andean areas of our country.

## **2 Materials and Methods**

### **2.1 Search Criteria**

The search for information took into account the reliability of the pages or databases consulted, such as Google Scholar, Scielo, Springer Link, Scopus, among others and approved theses, as well as the journal ranking databases such as SCIMAGO.

On the other hand, when evaluating the social, economic, and environmental impacts of geothermal energy, we have taken into account laws, regulations, and relevant information provided by the virtual platforms of the Ministries involved in our research, as well as the most renowned newspapers in our country and abroad that show the energy potential of geothermal energy in Peru.

### **2.2 Frosts and Fringes**

According to Editorial EC, 2022, Frost occurs when temperatures drop below 0 °C, this conception corresponds to meteorological frosts, but agrometeorological frosts, is the decrease in air temperature falls to critical values, which kills plant tissue. In the case of agrometeorological, frost depends on the critical temperature level of each crop and can be greater than 0 °C [9]. Frosts have already hit much of the country's Andean highlands, causing an increase in respiratory diseases linked to the coronavirus (COVID-19) pandemic, with the most affected regions being Puno, Arequipa, Tacna, Moquegua, Cusco, Ayacucho, Huancavelica, Pasco, Junín, and Apurímac.

EC Newsroom, 2022, describes that the cold begins with moderate to heavy rains, thunderstorms, and winds in a south-to-north direction. The maximum temperatures will be lower due to cloudiness, therefore, these rains advance leaving the sky almost clear, to clear the southern jungle and the presence of cold air caused the temperature to drop significantly in a few hours [9], frosts occur about 6–10 times a year, and the duration of these frosts lasts from 3 to 7 days, in many extreme cases up to 10 days.

### **2.3 Geothermal Potential in Perú**

In the field of energy production, we have an impressive water potential, along with natural gas more than 90% of electricity is produced, but we also have other promising sources such as geothermal heat, which comes from the heat of the interior of the earth [4], these geothermal deposits are originally found in hot springs and geysers.

Peru has abundant geothermal resources, where Master Plan estimates that Peru has geothermal potential to generate 3,000 MW distributed in thermal fields in the south of the country (60%). Therefore, Peru has implemented an integrated plan to

develop geothermal energy and contribute 1,000 MW of electricity by 2030 [10, 11]. This energy production will be constant and uninterrupted over time, since no other renewable energy (solar or wind), can be kept in operation for long periods since they suffer too many interruptions, mainly weather conditions. In addition, many experts say that geothermal energy is more efficient in the long term and thus provides greater energy security.

For Gonzales, 2022, Peru with its geothermal potential, can produce 3,000 MW, which is equivalent to 50% of the electricity currently produced throughout the country, this is due to our strategic and privileged location on the Pacific Ring of Fire [7]. As well as our country there are many others that have the same or even greater geothermal potential and reasons such as the growing energy needs have prompted Quaise Energy, they are embarking on an ambitious project; develop the deepest hole in the earth to extract geothermal energy [12] (see Fig. 1).

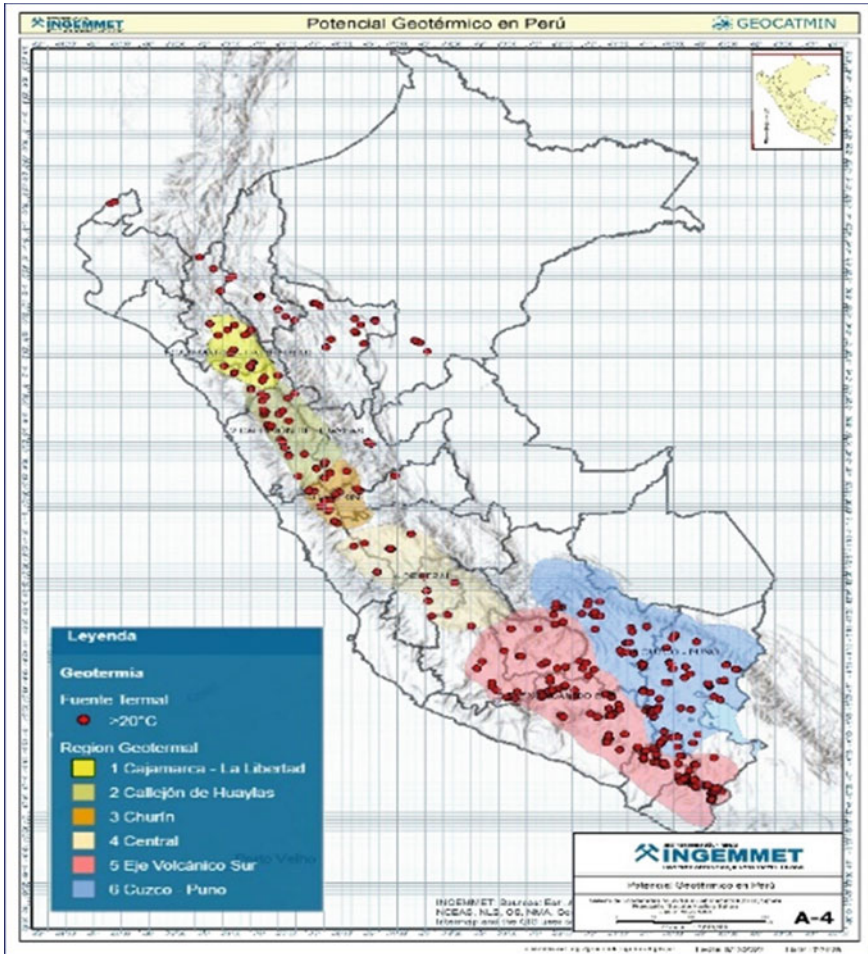
Normal geothermal development is concentrated in dry steam and hot steam systems; however, the enormous heat content of the Earth's interior is contained in dry rocks [13]. Therefore, Arequipa is one of the regions that intends to develop and explore the potential of renewable energy, this has generated public interest in promoting private investment for the exploration and exploitation of geothermal resources. Among the places of interest, we find that the Chivay—Pinchollo geothermal field has great potential, a generation power generation potential of 150 MW, the highest in the country, while the area can produce around 500 MW [14].

## 3 Results and Discussions

### 3.1 Social Impact

Peru has at least 44,000 population centers distributed in 17 regions of the country, where frost and cold hit in different ways. According to the National Center for Disaster Risk Estimation and Reduction (Cenepred), attached to the Ministry of Defense, 7 million 162,648 people are at a special level of vulnerability [6], where they suffer food shortages, loss of crops, loss of livestock, among others. Being the number of Peruvians vulnerable to low temperatures is very high, therefore, it is proposed the implementation of geothermal power plants, to achieve a widespread application in outdoor heating, homes, ponds or aquaculture centers and livestock centers.

According to the PNER, it diagnoses that Peru shows different special peculiarities such as; the remoteness, poor accessibility to localities, low consumption and low economic income make it impossible to use massive heating of large areas [15]. Under the deployment of renewable energy resources and emerging technologies will impact the development of the world, especially emerging market economies, provided that the development of appropriate technological solutions leads to greater prosperity



**Fig. 1** Distribution of geothermal potential in Peru. *Source* Energy and Mines Sector-INGEMMET (2022). *Note a* Distribution of thermal source and thermal region in Peru. *b* Distribution of geothermal areas in the southern region of the country

in society, creating new jobs and improving the quality of life [7]. According to the workers' unions, in Peru, the energy transition is necessary and just for life, humanity, the planet and nature, however, they must be done with a fair process that does not deprive workers of their jobs, especially in the mining, oil, fishing sector, etc. [16], in Peru, Supreme Decree No. 003-2022 has already been approved, where the climate emergency is declared of national interest and making it essential to face it. In turn, the health crisis experienced has taught us that a country will not be able to walk without its workers and in the energy transition it must be carried out with the participation of its workers and society itself.

According to Perego (2021), in the last decades, geothermal energy has proven to be a reliable and efficient technology to provide heat and/or cooling to both residential and non-residential buildings, including industrial or research facilities, the clearest example being the ELI-NP “extreme light infra-structure” plant in Magurele, Romania, these systems were mostly used in cold climates [17], this European experience encourages the development of this type of technology in the high Andean zones of our country. It is a very reliable, effective, and low-cost alternative to combat the frosts and cold spells that occur year after year, which will benefit more than 7 million Peruvians who live in critical conditions, mostly due to the increasing frost and cold spells.

### 3.2 *Environmental Impact*

The energy transition (ET) is a way to decarbonize the world’s energy systems, transforming them into carbon-free systems [1]. Geothermal power plants have become a renewable, environmentally friendly, and clean resource and are gradually being recognized, accepted, and valued [18] because they are very environmentally friendly.

Geothermal energy is a clean and renewable resource with abundant reserves, wide distribution and stable temperature, its development and use play an essential role in saving energy, reducing emissions and protecting the environment [18]. That said, renewable energies (solar and wind) are very susceptible to weather changes, however, geothermal energy is a more reliable, safe, affordable, and sustainable alternative capable of providing energy continuously and can be used worldwide and its implementation will contribute to minimizing the emission of greenhouse gases (GHG), thus mitigating climate change [19]. Geothermal projects are increasing in our country, for example, the regions of Arequipa, Trujillo and Loreto mainly, the latter has a project under evaluation, where specialists say that the non-consumption of fuels, makes it a sustainable alternative for the environment and most importantly, it will help reduce the conservation of the Amazon [20].

In 2020, the MINEM reports that in Peru the electricity demand amounted to 52,713 gigawatt-hours (GWh), in addition, around 5% has already been incorporated for the generation of electricity from renewable sources [4], also, in addition, geothermal energy is represented as an ecological alternative in energy production [7], since the source of heat emitted from the earth’s core is inexhaustible and permanent. It should also be added that due to climate change there have been variations in rainfall patterns, which means that it will probably rain too little or rain too much and, in both cases, in both cases, this directly affects the performance of hydropower plants [21].

This year several geological and geophysical studies carried out in the Peruvian offshore would reveal the geothermal potential in oil basins in the north of the country, specifically in the Trujillo Basin, since a high heat flow has been discovered in formations related to methane hydrates. According to this study, a geothermal gradient of

up to 100 °C has been found and it is configured as an alternative to giving a second life to the oil platforms that are installed and thus add to the energy transition [22].

It is normally considered that the use of geothermal energy does not cause any environmental impact, however, according to Bussotti (1997) who has compiled the description of several authors who have investigated the possible effects of emissions on terrestrial ecosystems, they have reported that the damage is macroscopic in the trees growing around the geothermal power plants that were examined for this study, which basically consists of yellowing and necrosis of the leaf margins. The authors attribute it mostly to the action of boron, these damages are localized and affect only trees growing no more than a few tens of meters from the power plants [23].

### ***3.3 Economic Impact***

For Falen (2021), the government's investment in the fight against frost and cold will reach about S/524 million this year. According to the Multisectoral Plan for these events, this figure exceeds those registered between 2014 and 2019, however, it is lower than the budget approved during 2020 (S/670 million) and 2021 (S/994 million) [24], also, according to the Ministry of Development and Social Inclusion (MIDIS), some 18 million soles were allocated this year to social programs for interventions to protect users from exposure to frost and cold in the high Andean and jungle areas, in order to protect health [25].

According to La Vega Polanco (2021), geothermal energy is a resource that can attract significant investments. Peru plans to invest more than US\$ 1,000 million in the construction of two geothermal plants in Arequipa (Achumani) and Moquegua (Quello Apacheta) with an initial capacity of 500 MW [4]. For Rumbo Minero (2020), the fact that Peru has a development potential of 3,000 MW makes it a very attractive country for this type of investment, which has a positive in the economy [8], many experts assure that the initial investment for the development of projects of this type is very high, however, they also indicate that the investment for this type of projects should be in the medium and long term.

Peru's economy has been plunged into a deep sea of doubt. First, even with the impact of the pandemic, combined with a series of bad public policy proposals has had a negative impact on confidence, reducing private investment [4]. According to the Central Bank, there will be no growth in 2022 and only moderate growth in 2023, however, if the government does this, there will be a great opportunity to restructure investments by promoting renewable energies and especially, investment in geothermal energy [11], in addition, according to Tuesta, investments in geothermal plants of US \$ 1000 million may generate 0.7–1.9% of annual economic growth to the Arequipa region, likewise, it is estimated that there will be an impact on poverty reduction of 0.2–0.5 percentage points each year [4].

Geothermal energy could be used for air-conditioning of tourist hotels and could include a thermal hot baths service in an environmentally friendly way, and it could even be up to 20% cheaper than fossil fuels such as fuel oil or diesel [26], however,

according to Oviedo, if these proposals are implemented, the positive impact on tariffs will be significant, since there will be a reduction of between 6 and 7% for the end consumer [21]. Acevedo also explains that the Achumani project has a potential of 700 MWh and the first 100 MWh will cost between US\$ 100 each, and the rest will be at market price [27], currently, the cost per MWh varies from US\$ 25 to US\$ 30, and the initial costs will compensate for the non-burning of fossil fuels and diesel.

## 4 Conclusions

The study shows that the geothermal potential in Peru is high, mainly due to its volcanic activity, with regions such as Puno, Arequipa, Moquegua, Ayacucho, Puno, and Pasco as the main areas of high viability to develop projects for the implementation of geothermal power plants, making it a usable resource for various activities throughout society. However, its energetic potential and availability in the Peruvian territory make it a renewable resource, since as the use of the resource increases, as it is estimated in the future, there will not be a decrease in its availability, and it is also environmentally friendly.

In the economic field, geothermal energy will contribute to a substantial increase in the economic growth of each region and consequently of the country. Reliability, inexhaustibility, durability, and low cost invite private investments to implement geothermal power plants to supply electricity to food industries, safe and natural heating, air conditioning of large areas and its non-susceptibility to weather changes make it an inexhaustible and safe energy source. Many experts assure that geothermal energy, due to its reliability, will be profitable in the short and long term, being the initial stage the most expensive, however, in the medium and long term, it could be up to 20% cheaper than traditional energies.

In the social field, the use of geothermal energy in Peru opens many employment centers in an amount of approximately 70,000 in the initial stage, according to many experts, and these will increase as the implementation, operation, and massification of geothermal energy are carried out, thus contributing to the reduction of unemployment and poverty rates at the national level. In addition, geothermal energy will help many high Andean areas with a very high vulnerability to low temperatures, to air-condition their areas, promote the creation of nurseries, intensify aquaculture, provide heating, among others, preventing the growth of the mortality rate in infants and older adults, massive deaths of livestock, loss of crops and food shortages.



## References

1. Rivera Delgado, D., Díaz López, F.J., Carrillo González, G., Rivera Delgado, D., Díaz López, F.J., Carrillo González, G.: Transición energética, innovación y usos directos de energía geotérmica en México: un análisis de modelado temático. *Probl. Desarro* **52**(206), 115–141 (2021). <https://doi.org/10.22201/IIEC.20078951E.2021.206.69713>
2. Pous, J., Jutglar, L.: Energía geotérmica. CEAC, Barcelona (2004). [https://books.google.com.pe/books?id=4DcMwnKF4wwC&printsec=frontcover&dq=energia+geotermica&hl=es&sa=X&redir\\_esc=y#v=onepage&q=energia%20geotermica&f=false](https://books.google.com.pe/books?id=4DcMwnKF4wwC&printsec=frontcover&dq=energia+geotermica&hl=es&sa=X&redir_esc=y#v=onepage&q=energia%20geotermica&f=false). Accessed 05 Dec 2022
3. Llorrenc Guilera, A.G.: La industria 4.0 en la sociedad digital. Marge Books, Barcelona (2019). <https://ebookcentral.continental.elogim.com/lib/unicont/reader.action?docID=5758826&query=energia+geotermica>. Accessed 04 Dec 2022
4. de la Vega Polanco, M.: Perú tiene potencial en la geotermia para suministrar energía eléctrica. *El Peruano*, Lima, 23 February 2021. <https://elperuano.pe/noticia/115835-peru-tiene-potencial-en-la-geotermia-para-suministrar-energia-electrica>. Accessed 05 Dec 2022
5. Ciriaco Ruiz, M.: Heladas y friaje: Más de 3,7 millones de hectáreas de cultivo están en riesgo por las bajas temperaturas. *Diario: El Comercio, NOTICIAS EL COMERCIO PERÚ*, Lima, 05 July 2022. <https://elcomercio.pe/peru/heladas-y-friaje-mas-de-37-millones-de-hectareas-de-cultivo-estan-en-riesgo-por-las-bajas-temperaturas-senamhi-cenepred-ecdata-noticia/>. Accessed 09 Dec 2022
6. Bazo Reisman, A.: Heladas y friaje: Más de 7 millones de peruanos entre los más vulnerables ante las bajas temperaturas. *Diario: El Comercio, NOTICIAS EL COMERCIO PERÚ*, Lima, 03 July 2022. <https://elcomercio.pe/peru/heladas-y-friaje-mas-de-7-millones-de-peruanos-entre-los-mas-vulnerables-ante-las-bajas-temperaturas-vacunacion-invierno-cenapred-ecdata-noticia/>. Accessed 09 Dec 2022
7. Minero, R.: Potencial geotérmico peruano equivale al 50% de la electricidad que producimos. *Rumbo Minero Internacional*, 13 February 2020. <https://www.rumbominero.com/peru/noticias/energia/potencial-geotermico-peruano-equivale-al-50-de-la-electricidad-que-producimos/>. Accessed 05 Dec 2022
8. Peña Jumpa, A.: Heladas, Granizadas, Nevadas, Friajes y el Derecho a la Calefacción en los Andes. *Agro Enfoque* **29**(192), 53–54 (2014). <https://pwebebsco.continental.elogim.com/ehost/detail/detail?vid=3&sid=90314f44-3084-4f3c-b5d6-b1362ad243cd%40redis&bdata=Jmxhbm9ZXMmc2l0ZTl1aG9zdC1saXZl#AN=95395316&db=a9h>. Accessed 09 Dec 2022
9. Redacción EC: ¿Qué son las heladas, nevadas y friajes? Senamhi te precisa los conceptos. *Diario: El Comercio, NOTICIAS EL COMERCIO PERÚ*, Lima, 30 June 2022. <https://elcomercio.pe/lima/sucesos/invierno-2022-que-son-las-heladas-nevadas-y-friajes-senamhi-te-precisa-los-conceptos-frio-enfermedades-respiratorias-rmmn-noticia/>. Accessed 09 Dec 2022
10. Ministerio de Energía y Minas (MINEM): Plan maestro para el desarrollo de la energía geotérmica en el Perú, February 2012
11. Tuesta, D.: Sobre volcanes, energía y crecimiento sostenible. *Diario: El Comercio, NOTICIAS EL COMERCIO PERÚ*, Lima, 02 October 2022. <https://elcomercio.pe/economia/peru/david-tuesta-sobre-volcanes-energia-y-crecimiento-sostenible-consejo-privado-de-competitividad-noticia/>. Accessed 05 Dec 2022
12. Gonzales, R.: Planean hacer el agujero más profundo de la Tierra para extraer una energía ilimitada. *La Republica*, Lima, 12 March 2022. <https://larepublica.pe/ciencia/2022/03/11/planean-hacer-el-agujero-mas-profundo-de-la-tierra-para-extraer-una-energia-ilimitada-energia-geotermica/>. Accessed 05 Dec 2022
13. Fink, D.G., Wayne, B.H., Carroll, J.M.: *Manual Practico de Electricidad Para Ingenieros: Tomo 3, vol. 3, 11th edn.* REVERTE S. A., Barcelona (1984). <https://books.google.com.pe/books?id=0MvCfacWoLcC&pg=RA9-PA11&dq=energia+geotermica&hl=es&sa=X&ved=2ahUKEwis3qi6o-T7AhWcLrkGHRhPC0wQ6AF6BAgJEA1#v=onepage&q=energia%20geotermica&f=false>. Accessed 05 Dec 2022

14. Jorquera, C.: Arequipa en Perú, busca potenciar energía geotérmica. Piensa en GEOTERMIA, 01 August 2017. <https://www.piensageotermia.com/arequipa-en-peru-busca-potenciar-energia-geotermica/>. Accessed 05 Dec 2022
15. Direccion General de Electricacion Rural: Plan Nacional de Electrificación Rural 2021–2023. Lima, Lima, December 2020
16. Jara, M.: Transición energética justa con trabajo digno, la demanda en Perú. Inter Press Service: Periodismo y comunicacion para el cambio global, Lima, 08 September 2022. <https://ipsnoticias.net/2022/11/transicion-energetica-justa-con-trabajo-digno-la-demanda-en-peru/>. Accessed 05 Dec 2022
17. Perego, R., Pera, S., Boaga, J., Bulgheroni, M., Dalla Santa, G., Galgaro, A.: Thermal modeling of a Swiss urban aquifer and implications for geothermal heat pump systems. *Hydrogeol. J.* **29**, 2187–2210 (2021). <https://doi.org/10.1007/s10040-021-02355-7/Published>
18. Hou, J., Luo, X., Zhang, L.: Establishment of evaluation model for shallow geothermal energy resource development potential based on characteristic of geotemperature. *Earth Sci. Res. J.* **24**(3), 312–320 (2020). <https://doi.org/10.15446/esrj.v24n3.89513>
19. Vega-Garzon, L.P., Parra Ramos, J.A., García Sarmiento, M.P., Ruiz Gaitán, M.A., Pedraos Juya, L.A.: Use of geothermal energy in the food industry: a review. *Revista Ingenierías Universidad de Medellín* **21**(40), 67–86 (2022). <https://doi.org/10.22395/rium.v21n40a5>
20. Jorquera, C.: Resumen webinar: Perspectiva tecnológica de energía geotérmica para Loreto, Perú. Piensa en GEOTERMIA, 09 August 2022. <https://www.piensageotermia.com/resumen-webinar-perspectiva-tecnologica-de-energia-geotermica-para-loreto-peru/>. Accessed 05 Dec 2022
21. Lozano Alfaro, V.: Energías renovables: cambio necesario con visión de futuro para asegurar sostenibilidad. *El Peruano*, Lima, 05 December 2022. <http://www.elperuano.pe/noticia/198353-energias-renovables-cambio-necesario-con-vision-de-futuro-para-asegurar-sostenibilidad>. Accessed 05 Dec 2022
22. Jorquera, C.: Webinar: La geotermia podría alargar la vida de las plataformas petroleras off shore del Perú, 14 de Junio. Piensa en GEOTERMIA, 14 June 2022. <https://www.piensageotermia.com/webinar-la-geotermia-podria-alargar-la-vida-de-las-plataformas-petroleras-off-shore-del-peru-14-de-junio/>. Accessed 05 Dec 2022
23. Bussotti, F., Cenni, E., Cozzi, A., Ferretti, M.: The impact of geothermal power plants on forest vegetation. A case study at Travale (Tuscany, central Italy). *Environ. Monit. Assess.* **45**, 181–194 (1997)
24. Falen, J.: Recursos aprobados para enfrentar las heladas y el friaje serán los más bajos de los últimos tres años. *Diario: El comercio, NOTICIAS EL COMERCIO PERÚ*, Lima, 17 July 2021. <https://elcomercio.pe/peru/recursos-aprobados-para-enfrentar-las-heladas-y-el-friaje-seran-los-mas-bajos-de-los-ultimos-tres-anos-informe-bajas-temperaturas-invierno-covid-19-ec-data-noticia/>. Accessed 09 Dec 2022
25. Redaccion EP: Medidas frente a heladas y friaje. *Diario Oficial El Peruano*, Lima, 23 June 2022. <https://elperuano.pe/noticia/162127-medidas-frente-a-heladas-y-friaje>. Accessed 11 Dec 2022
26. Anonymous: Entregan concesiones para explotar energía geotérmica en cinco estados: [1]. *Business and Economics*, Mexico, 22 July 2015. <https://www.proquest.com/docview/1698014887/F690BB6605FD4073PQ/5?accountid=146219>
27. Caretas: Energía geotérmica/Calor de Tierra. *Ilustracion Peruana CARETAS*, Lima, 22 October 2022. <https://caretas.pe/medio-ambiente/energia-geotermica-calor-de-tierra/>. Accessed 05 Dec 2022