POTENTIAL DEVELOPMENT ZONES FOR GEOTHERMAL DIRECT USES IN MEXICO WITH A SPECIFIC SITE RECOMMENDATION

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ABSTRACT

For many years, the direct use of geothermal resources in Mexico has been underestimated; although there are few places exploiting it, it is only used for recreational purposes such as baths or spas. Over the past 30 years, the electricity supplier in Mexico (Comisión Federal de Electricidad, CFE) has explored, drilled and developed geothermal projects all over the country, having only the aim of large scale electricity generation. Sometimes, wells in zones with appropriate conditions for a direct use benefit, are abandoned. Most of these wells and studies are located in areas where the economic development is poor and the implementation of direct use geothermal projects such as greenhouses, fish farms, drying processes, heating processes, evaporation and distillation processes, washing, desalination and chemical extraction, may improve this situation with the increase of jobs and opportunities to these communities. The objective of this study is to make an overview of the potential zones in Mexico suitable for the development of geothermal direct uses, and to choose a specific location to apply it.

INTRODUCTION

Geothermal Direct Uses

A geothermal direct use project uses a natural resource, a flow of geothermal fluid at elevated temperatures (15-150°C), which is capable of providing heat and cooling to buildings, and many other infrastructures or processes. The geothermal potential can be used in cascade arrangements, where applications with the highest temperatures will be installed first (i.e. process heat applications or district heating), while applications with the lowest temperature (such as fish farming) follows at the end of such cascade.

Direct Use Applications

The different direct use applications are:

1. Bathing and balneology (hot spring, medical and spa bathing)
2. Agriculture (greenhouses, soil sterilization, drying processes, warming processes).
3. Farming (fish, prawn, breeding, mushroom cultivation farms)
4. Industrial use (product drying or warming, linen and clothes bleaching, steam application processes, metallurgic smelter processes like aluminum and zinc industries).
5. Residential – and district heating or cooling (including hotels, schools, hospitals, factories, office buildings).
6. Shallow geothermal use applications (residential heating, heat pumps, etc.)

GEOTHERMAL POWER IN MEXICO

The first geothermal plant installed in Mexico was in 1959, Pahte, Hidalgo, with a capacity of 3.5 MW (Hiriart, 2011), but it was shut down years later. The geothermal energy in Mexico at great scale has been active since the 70's and now there are 38 units with an installed capacity of 958 MWe(Figure 1). This is a big infrastructure, but in the case of geothermal direct use, the use is minor compared with the capacity for electricity generation. Even if in recent years there has been an important increase in the exploitation of this resource, Quijano (2007) reports that in 2005 the capacity for direct use was 27,824 MWt with the main uses being heat pumps, recreation and heating (Figure 2).

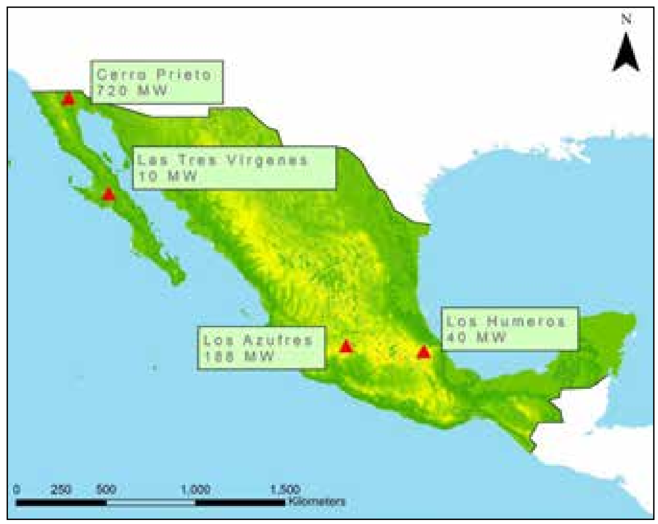

Figure 1 Geothermal fields in Mexico.

Ordaz-Mendez, et al. (2011) estimates that there is probable geothermal potential of 2,077.01 MWe in the entire country, separating the different temperatures of the potentials as shown in Table 1.

DIRECT USE IN MEXICO

For many years CFE has developed several projects all over the territory, most of them successful and some of them not, this may be due to the lack of interest by authorities or investors. Most of these abandoned projects are cases of temperatures between 90 and 200°C that could be suitable for direct use. There are cases, like Ixtlan de los Hervores, Michoacan, in which there are perforated wells and they are only being used for recreational purposes like an artificial geyser.

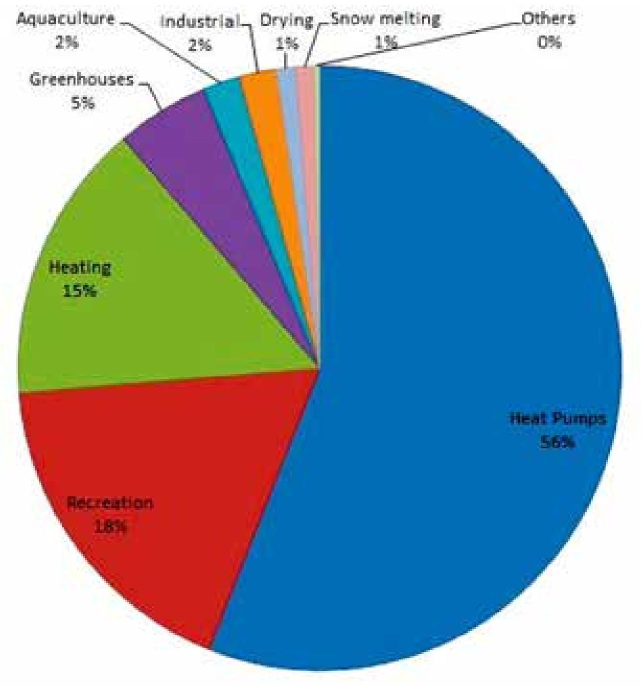

Figure 2. Percentage of direct use in 2005 (Quijano, 2007).

Table 1. Geothermal potential in Mexico (Ordaz-Mendez, et al., 2011)

Temperature °C	Geothermal potential MWe
>200	1,643.94
150 – 200	220.37
90 – 150	212.70
Total	2,077.01

The advantages of direct use have been underestimated since, in many communities where there is access to this, remains largely untapped and with high potential to generate sources of income and employment. One of the most interesting places is Ensenada. Arango-Galvan, et al, (2011) made an integration of geochemical and geophysical data to identify a shallow geothermal reservoir at Punta Banda and determined the best site for future exploration drilling. This study suggests that thermal waters of Agua Caliente area might have temperatures that are adequate for small desalination plants, and there is also opportunity for small scale electricity production for the touristic zone in the area.

Elders, et al., (1996) estimated the potential of direct use in Tulecheck, Baja California. The conclusion was that more than 10 TJ of geothermal energy could be recovered by pumping >70°C hot water from only 300 m depth. This study was only focused on district cooling systems in Imperial and Mexicali Valley, but other possibilities of direct use are not referred, as greenhouses, aquaculture or industrial.

One of the possible main factors for the slow development of direct use in Mexico could be the subsidized prices of electricity but this is changing with the raise in the cost of fossil fuel. Subsides are becoming only for small consumption; with the new technologies in geothermal development, the investment level to achieve a reasonable payback time could be reasonable in these days capitalize on direct use.

The possible direct use locations are based in the analysis of Ordaz-Mendez, et al., (2011), geochemistry, geological and geophysical reports from CFE and such other works mapping geothermal areas in the country. Direct use could be employed by these communities to satisfy some alimentary and district heating needs.

Chihuahua is one of the states that could most benefit from direct use, due to the remoteness of some communities and climate extremes (in summer heat is very intense, and in winter temperatures are very low). According to Torres-Rodriguez (2000), in the state are known 53 thermal localities (Figure 3). For this investigation, we focus on a special case: Maguarichi, Chihuahua (Figure 4).

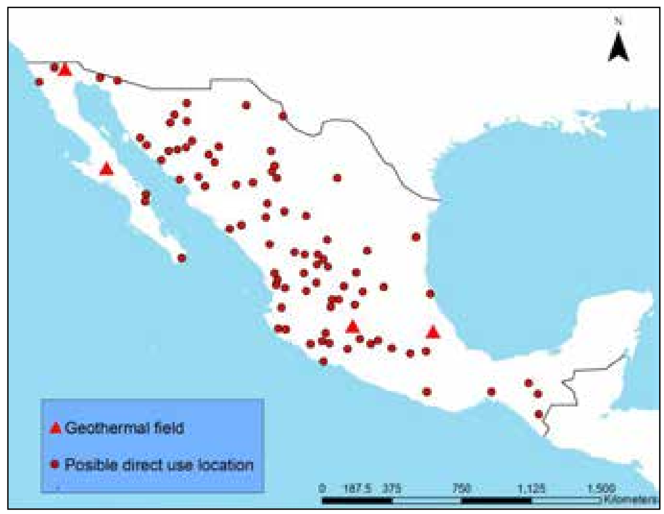

Figure 3. Possible direct use locations in Mexico

MAGUARICHI

Maguarichi is a little village located at the Sierra Madre Chihuahuense. With a territorial extension of 1012.16 km^2 and 1690 masl, there are 1921 inhabitants and 537 houses, where most of the entire territory belongs to the inhabitants.

The weather is semi-extreme with a maximum temperature of almost 40˚C and a minimum of -14˚C, extremely cold in the mountains and highlands, where frost and snow are common, and very hot in canyons bottoms, with an average annual rainfall of 790.0 mm.

Geothermal Potential

The geothermal potential in Maguarichi is:

- 96 geysers or natural manifestations
- Average temperature of water 95-98˚C (114˚C hottest, up to 4 m height)
- Above 200 m depth, no pressure but temperature
- Natural recharge of the reservoir (filtered rain)
- More than 12 thermal waters

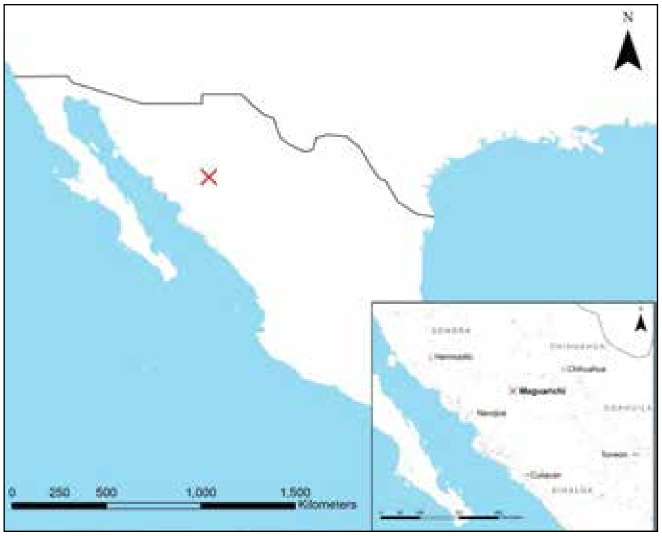

Figure 4. Location of Maguarichi, Chihuahua.

Why Maguarichi?

It has a proved geothermal resource. In 2001, a geothermal project was developed: a 200 kW Ormat Binary Power Plant off-grid was installed providing electricity to Maguarichi. In 2007 this plant was shut down due to the energy was not enough to accomplish the load and CFE started supplying the needed electricity. Nowadays, the binary plant is owned by a university but the wells remain on site. While producing, the mass flow rate was 35 ton/hr with a temperature of 98ºC in well PL-2, with only 300 m depth and 244.5 mm diameter.

There was another test-well drilled, which has 49 m depth, 88.9 mm diameter and registered pressurized water at 120˚C.

The advantages are:

- Great potential to develop the community as a sustainable village with geothermal direct uses.
- Seasonal agriculture (such as Chiltepin) occurs only during summer months.
- Disposition of the village to further development and usage of the geothermal resources.

Figure 5 shows a diagram for direct use in Maguarichi.

CONCLUSIONS

- There is great potential of geothermal direct use development in Mexico; approximately 212 MWe could be used for heating, greenhouses and aquaculture at big scale.
- Government should promote usage of alternative energies. Incentives and subsidies for investors could create more interest from people to develop this resource.
- As exemplified in this study, there are places with unused infrastructure that could be exploited for communities benefit.

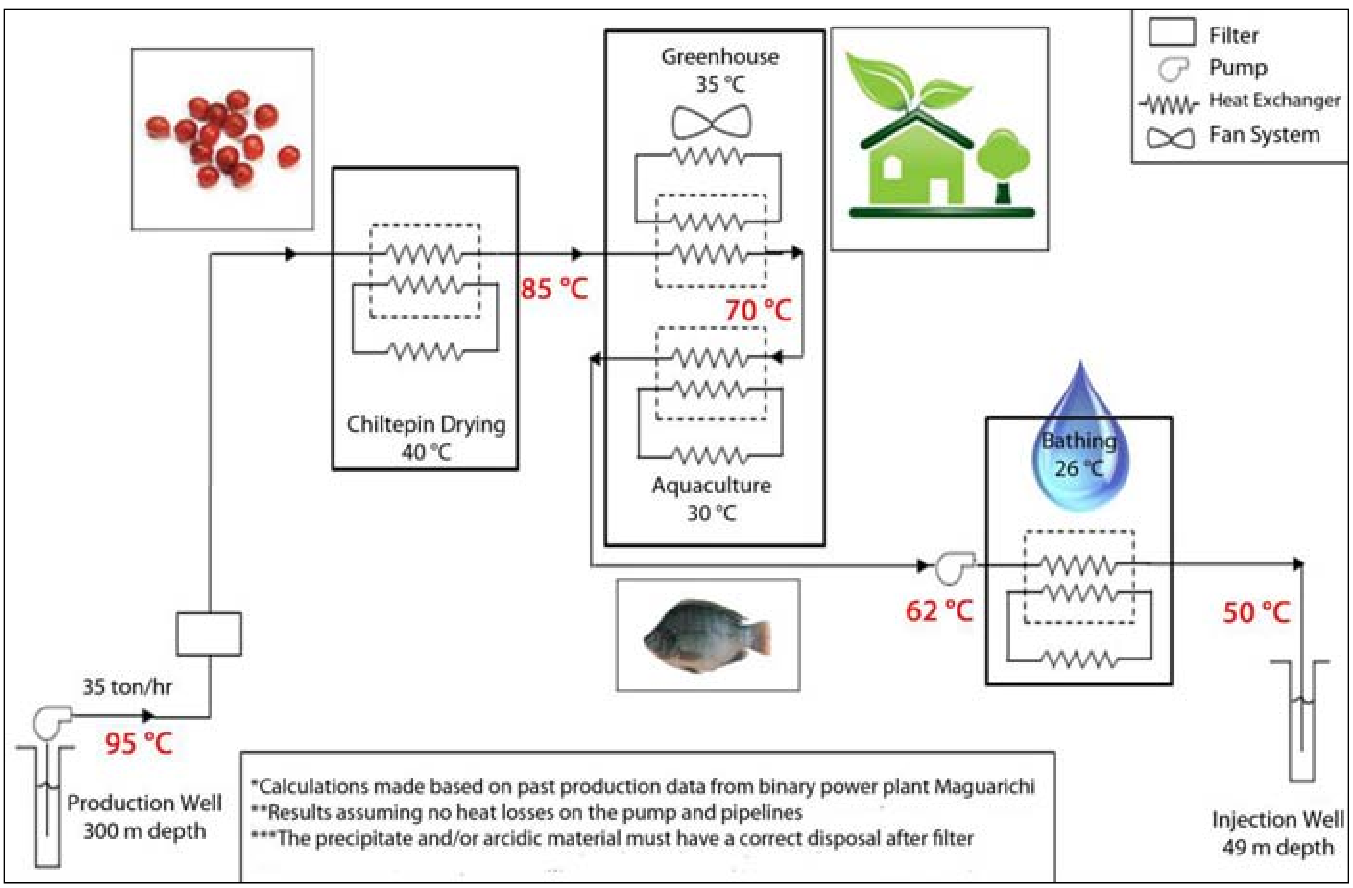

Figure 5. Diagram for direct use in Maguarichi.

- Maguarichi has a great potential to develop many direct use geothermal projects due to the availability of this resource. Projects, such as previously described, would help in the economical development of the village and its inhabitants.
- Further application of geothermal use is recommended (like geothermal heat pump installations, which require a district heating system or individual geothermal heat pump within private housings).

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