Presented at Workshop for Decision Makers on Geothermal Projects in Central America, organized by UNU-GTP and LaGeo in San Salvador, El Salvador, 26 November to 2 December 2006.

GEOTHERMAL PROJECTS AND PROTECTED AREAS IN MEXICO

Luis Quijano
Geothermal Division, Deputy Direction of Generation
Federal Commission for Electricity
Morelia
MEXICO
luis.quijano@cfe.gob.mx

ABSTRACT

Mexico has a quite well established environmental framework for the management of protected areas. The possibility for the construction of geothermal power plants depends on the type of protected area and the zone classification within each individual area. The procedure to obtain the environmental licence includes the submission of an Environmental Impact Assessment (EIA) that should be elaborated according to a specific guide. The EIA is subjected to the analysis and opinion of experts, the local authorities and the public opinion.

CFE's experience with geothermal projects in protected areas is complex. There is the example of a successful case, the Tres Vírgenes Filed, and a difficult case, La Primavera (Cerritos Colorados) Field, which is up to now suspended. The former project was constructed under a well defined environmental regulatory framework. The project was planned and executed with strict environmental specifications. The project also had a clear social and economic benefit for the community and CFE establish a good relationship with local inhabitants. On the contrary, the later project was initiated before the environmental law was passed and the regulatory framework of the protected area was somehow ambiguous. The road opening and pad construction for the exploratory drilling was executed with little care to the environment. The environmental authority ordered the suspension of the project. This is still the situation at present.

Developers and operators should be actively involved in the establishment of official norms and management programs for protected areas to avoid to restrictive provisions that would prevent the development of new geothermal capacity.It is also important to develop a good relationship with local communities and to explain to public opinion the benefits of the projects and the measures taken to prevent or minimize the impacts. The cooperation with the management staff of the protected area in reforestation, restoration and educational workshops is essential.

1. INTRODUCTION

It is not uncommon to have geothermal resources in areas of environmental worth. Mexico is not the exception. Since 1988, when the Environmental Law was published, the Mexican Government has made continuous efforts to declare and administrate "protected areas", within a well established legal framework. The Federal Commission for Electricity (CFE), the public utility in charge of the generation, transmission and commercialization of electric power in Mexico, has also adopted a

decided commitment with the environmental protection and, therefore, has improved its engineering and operational standards to fulfil these requirements.

2. LEGAL FRAMEWORK

The environmental issues related to infrastructure projects, as it is the case of power generation and transmission, are regulated by the "General Law for the Ecological Equilibrium and the Environmental Protection" ("Ley General del Equilibrio Ecológico y la Protección Ambiental", LGEEPA). The same law includes all provisions concerning the establishment and administration of highly valuable ecological areas as "protected areas". That means that the approval of electricity projects and the administration of protected areas fall under the authority of the federal government.

Protected areas are defined as "terrestrial or aquatic portions of the territory that represent the different ecosystems, where the natural conditions are not essentially altered and produce highly priced environmental benefits". There are different categories of protected areas, according to the extension, significance, characteristics, management program, etc. (Table 1).

TABLE 1: Number of protected areas in Mexico, category and extension

Number	**Category**	**Surface (km^2)**
35	Biosphere Reserves	109 565,05
67	National Parks	14 569,88
4	National Monuments	140,93
2	Natural Resources Protection Areas	397,24
28	Flora and Fauna Protection Areas	60 731,27
17	Sanctuaries	6,89
1	Declaration pending	1 867,34
154	***TOTAL***	***187 278,80***

The total extension represents 9,3 % of the Mexican territory.

In the declaration of a protected area, the following information should be included:

1. The precise location and delimitation of the area.
2. Conditions and manners to which the use and exploitation of the natural resources should be subjected.
3. Description of the allowed activities.
4. General dispositions for the establishment of a collegiate body for the administration.
5. General dispositions for the establishment of financial funds or trustees.
6. General dispositions for the elaboration of the management program and the vigilance and administration rules.

From the practical and operational point of view, the management program is the most important document. It includes a description of the area, an ecological diagnosis and assessment of the problems, a delimitation of different zones in accordance with the diagnosis and the allowed activities in each zone.

The administration of protected areas is organized and supervised by the National Commission for Protected Natural Areas (Comisión Nacional de Areas Naturales Protegidas, CONANP), under the environmental authority. Their objectives are: a) to preserve the natural patrimony of Mexico and the

ecological processes through the Protected Natural Areas and sustainable regional development programs; b) to promote the use, with sustainability criteria, of the ecosystems, their goods and services, involving the indigenous and rural groups in the design, property and operation of the productive activities.

2.1 Environmental Impact Assessment

When there is an electricity project located within a protected area, the first step is to check if it is allowed by the management program. If the answer is positive, the project's owner should submit an Environmental Impact Assessment (EIA) to the federal environmental authority (Secretaría del Medio Ambiente y Recursos Naturales, SEMARNAT). There are two types of EIA: particular and regional. The later one is requested when the project has an impact in a large area, i.e. a basin, or has a significant length, i.e. a railroad or a highway. The regional EIA should be also submitted, even if the project covers a smaller area, when accumulative or synergic impacts that may endanger an ecosystem are foreseen. The EIA should be done according with the following items:

1. Basic information about the project and the person responsible for it
2. Description of the project
3. Laws and regulations applicable to the project
4. Description of the ecological system and environmental risks in the influence area of the project
5. Description and assessment of the environmental impacts
6. Proposed actions to prevent or mitigate the impacts
7. Request for approval for change of the land use in the project site
8. Prediction of the environmental behaviour due to the project influence
9. Description of the methodology and techniques used in the EIA elaboration

There is a specific guide for power generation projects available to help in the elaboration of the EIA.

Once the EIA is submitted, the environmental authority should open it for public consultation and the project responsible should publish an abstract in a newspaper of wide distribution.

The environmental authority should also ask for the opinion of the State and Municipal Government and the CONANP and may invite a panel of experts to express their opinions. The authority has a period of 60 days to give a resolution.

The approval may be conditioned and the project responsible may be asked to make modifications or include additional actions to prevent the impacts. Usually the project responsible is asked to carry out compensatory actions, like reforestation, educational workshops, restoration, payment for environmental services, etc.

2.2 Mexican Official Norms

There are several environmental official norms (Norma Oficial Mexicana, NOM). Among them:

- Residual water disposition
- Noise levels in populated and non populated zones
- Air quality (H_2S not included)
- Emissions to the atmosphere (H_2S not included)
- Dangerous and industrial waste disposition
- Civil work: opening of roads, earth movements, exploitation of quarries, etc.
- Soil protection and management
- Protection of native and endangered fauna and flora species

2.3 Environmental inspection

The Federal Government has an entity which is responsible for the inspection and vigilance of the observance of the environmental regulation. It is called Federal Attorney's Office for Environmental Protection ("Procuraduría Federal de Protección al Ambiente", PROFEPA).

It has a very successful program by which the facilities subjected to it authority can voluntarily request for an official inspection. This program has been very useful to improve the environmental quality of the industrial facilities in Mexico. Once the improvements recommended by the inspection have been adopted, the facility is granted with a "Clean Industry Certificate".

3. THE TRES VIRGENES GEOTHERMAL FIELD

This is an example of a successful development and operation of a geothermal field located within a protected area. It is located in the middle part of the Baja California Peninsula, near by Santa Rosalía City (Figure 1). The estimated potential is 25 MW. At present there are two 5 MW condensing power plants, fed by the steam of 3 production wells. Separated water is reinjected in 1 well; there are 2 backup reinjection wells. The power is delivered to a small local grid. Average demand varies between 4 and 8 MW, according to the season, and peak demand is of the order of 13 MW.

The field is located in the Vizcaíno Biosphere Reserve, the largest in Latin America, with a total surface of 25 468 km^2 and 5 km of coastal strip on both sides, the Gulf of California and the Pacific Ocean (figure 2).

It is one of the regions in Mexico almost unaffected by human activities. There are many valuable features and a rich wild flora and fauna. The Vizcaíno desert is a typical example of the so called North American Desert ecosystem. Two coastal lagoons in the pacific side, "Ojo de Liebre" and "San Ignacio" are worldwide famous breeding sanctuaries of the Gray Whale. Mangrove swamps are abundant. There are spectacular geological structures: the Reforma Caldera with an age of 4 to 1,5 million years, the Aguajito Complex formed by a number of rhyolitic domes and the Tres Vírgenes Volcanic Complex formed by three quaternary volcanoes, La Virgen, El Viejo and El Azufre. La Virgen, a composite volcano, had an eruptive event in 1746. The geothermal field is close to El Azufre.

The fauna is represented by the Gray Whale, Puma, Wild Rams (Borrego Cimarrón), Bura Deers, Speckled Antelopes (Berrendo); birds like the Royal and Fisher Eagles, Migrating Hawks; Boas and Rattlesnakes and many other minor animals. There is a large variety of flora, possibly the richest variety of desert plants worldwide, including giant cactus.

The cultural and historical features are represented by the rupestrian paintings in the Sierra San Francisco, made by the local Indians. It is considered that painting activity started 4 000 years ago and ended when the Spaniards arrived around 1650. The City of Loreto, south of the protected area, was a jesuitic mission founded in 1697. It is considered the 'mother' of all the missions in the Baja and Alta California, including many of the today largest cities in the western part of the United States, i.e. San Diego, Los Angeles, San Francisco. Some of these old missions are still well preserved in the region.

The reserve is divided in two different types of zones, according to the management program: a) The core zones, with a total surface of 3 634 km^2, include the Whale sanctuaries in the lagoons…. b) The buffering zones, with a total surface of 21 834 km^2, which is divided in zones of restricted use and zones where the exploitation of natural resources is permitted. In addition, both lagoons and the Sierra San Francisco have been declared World Heritage by UNESCO.

Surface exploration activities were carried out in the 80's. In the next decade several exploratory wells were drilled. The power plants were commissioned in 2001.
There are several reasons why this project has been a success from the environmental point of view:

- When the construction works started, the environmental regulation was well defined. The geothermal field is located in a zone where the exploitation of natural resources is allowed.
- There is a clear social and economic benefit for the local population. Prior to the installation of the geothermal plant, the electricity was generated by old inefficient internal combustion diesel engines. The price of the fuel, including transportation to this remote site, was very expensive.
- There are no large cities near the geothermal project. The experience in Mexico shows that infrastructure projects located close to major cities are more questionable.
- There is a good relationship with local communities. The project also helped to improve their standards of life.
- The size of the project is rather small.
- Minimized impacts: narrow access roads, 2 km of subterranean transmission line, small and rustic camp in the site (the main offices are located in Santa Rosalía City, outside the protected area).
- Cooperation with the administrators of the protected area in preservation programs: nursery for endemic desert plants, educational workshops for local residents, reforestation and restoration activities, etc.

4. THE LA PRIMAVERA GEOTHERMAL FIELD

Contrary to the previous case, this is a project with a conflictive history. At present, the environmental issue is still an obstacle to continue with the development of the project. The geothermal field is located very close to Guadalajara City, the second largest city in Mexico (Figure 1). Surface exploration was carried out at the end of the 70's. During the 80's twelve wells were drilled. The estimated capacity of the reservoir is 75 MW. In 1989, the project was suspended by an order of the environmental authority and the reopening was conditioned to the restoration of the impacts. From 1989 to 1993, CFE carried out an intensive and effective restoration work. At present, the project is still suspended.

The geothermal field is located within a quaternary caldera that started to form 100 000 years ago. The latest activity, some rhyolitic domes in the periphery, was around 20 000 years ago. The caldera is part of a larger pine and oak forest know as "La Primavera". The forest, with a total surface of 305km^2, is a Flora and Fauna Protection Area. It is divided in several zones (Table 2).

TABLE 2: Delimitation of "La Primavera" Protected area

Type of zone	% of surface
Core (most protected)	13
Restricted	50
Natural resources exploitation	2
Agrosystems exploitation	6,5
Special use (geothermal area)	1,4
Public use	5
Restoration	20

The geothermal field is an area known as “Cerritos Colorados”, with a surface of 4,5 km^2 (Figure 3). According to the management program, it is allowed to make use of the geothermal resource for electricity generation.

The main features of the protected area are:

- Pine and oak forest
- Presence of a variety of orchid species
- Fauna: white tail deer, wild cat, gray fox, aguarondi, cacomixtle, coyote, owl and other birds
- It is important for the quality of the environment around Guadalajara City
- Several hot springs and spas
- Some peculiar geological features, like giant pumice stones

This is a problematic project because of the following reasons:

- When drilling started in 1980, the environmental regulation did not exist; the law was passed in 1988. The forest had a rather ambiguous legal status. There was a Decree declaring it a protection area; but with no management program that could delimitate the different uses.
- It is close to a major city and the inhabitants are convinced that the forest is the last green area around the city that helps in improving the quality of the environment. That means that the project has a bad image or, at least, is controversial.
- There is a strong opposition of several groups of ecologists and part of the local public university.
- There is some antagonism between the local government and the federal authorities.
- Al the beginning of the drilling the civil work, mainly the road and pad construction, was done with little care.
- When testing the production wells, some soil spots were contaminated with brine and scaling.

In spite of the conscientious restoration work carried out by CFE, which was audited and approved by PROFEPA, the EIA has been rejected twice by the environmental authority. At the beginning of the drilling works wrong decision were taken, which gave a bad public image of the project. Now, it is difficult to overcome this situation.

5. DISCUSSION

In the last years, the construction of infrastructure projects, including geothermal plants, has become a controversial or, at least, a difficult issue, due to an increasing public concern for the environment. It is, therefore, essential to have a clear regulatory framework, mainly in protected areas. This framework should be established with the participation of the different interested groups, i.e. ecologists, developers, local communities and authorities.

The official norms and the management programs of protected areas are, usually, written by an expert panel, that represents different interests. The draft is published during some period of time for public consultancy and suggestions. It is very important for geothermal developers and operators to actively participate in this procedure, to avoid too restrictive provisions in the legal documents.

The development of a good relationship with local communities is very important. In CFE’s geothermal field the unskilled jobs, like road cleaning and maintenance, reforestation and some restoration jobs, are contacted with local workers.

It is essential to establish a cooperation program with the management of the protected area. The program may include periodic educational workshops for local communities about the reserve, restoration jobs in deteriorated zones, reforestation, etc.

There is now in Mexico an experimental program based on the so called “payment for environmental services”. The basic conception is that the infrastructure projects in protected areas, or even in any kind of forest, should pay some percentage of the total cost of the project for the environmental services that the area provides just for the very fact that it exists, like biodiversity, beauty, clean air, groundwater recharge, amusement, carbon capture, etc. This money would be used by the local communities to improve their life standards and preserve the protected areas; under well defined rules and the surveillance of the authority.

REFERENCES

Most of the legal and regulatory documents are available in the following site: www.semarnat.gob.mx/

Technical information was obtained from unpublished CFE’s internal reports.

FIGURES

FIGURE 1: Location of the Mexican geothermal fields

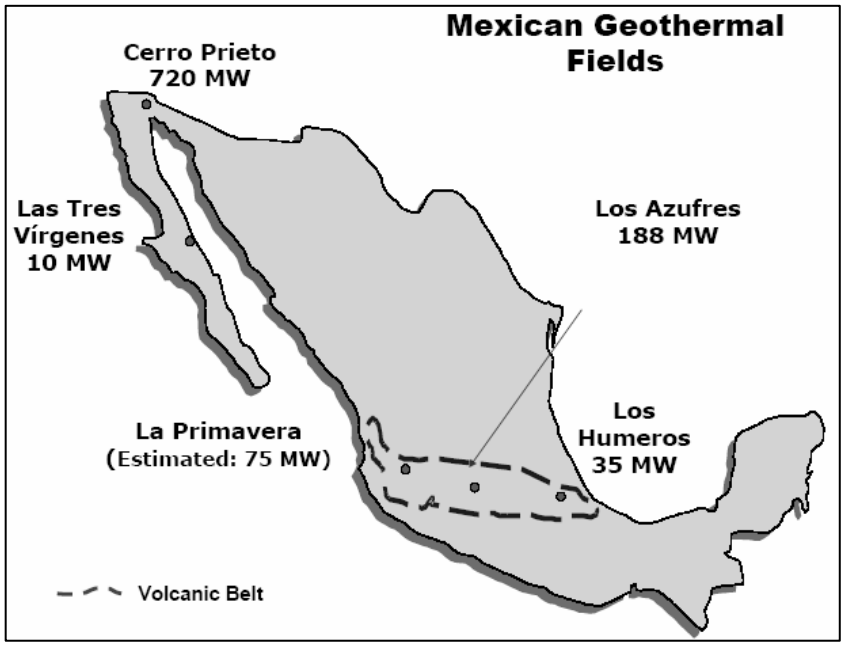

FIGURE 2: Map of the Vizcaíno Biosphere Reserve. The geothermal project is located in the vicinity of the Las Tres Vírgens Volcano

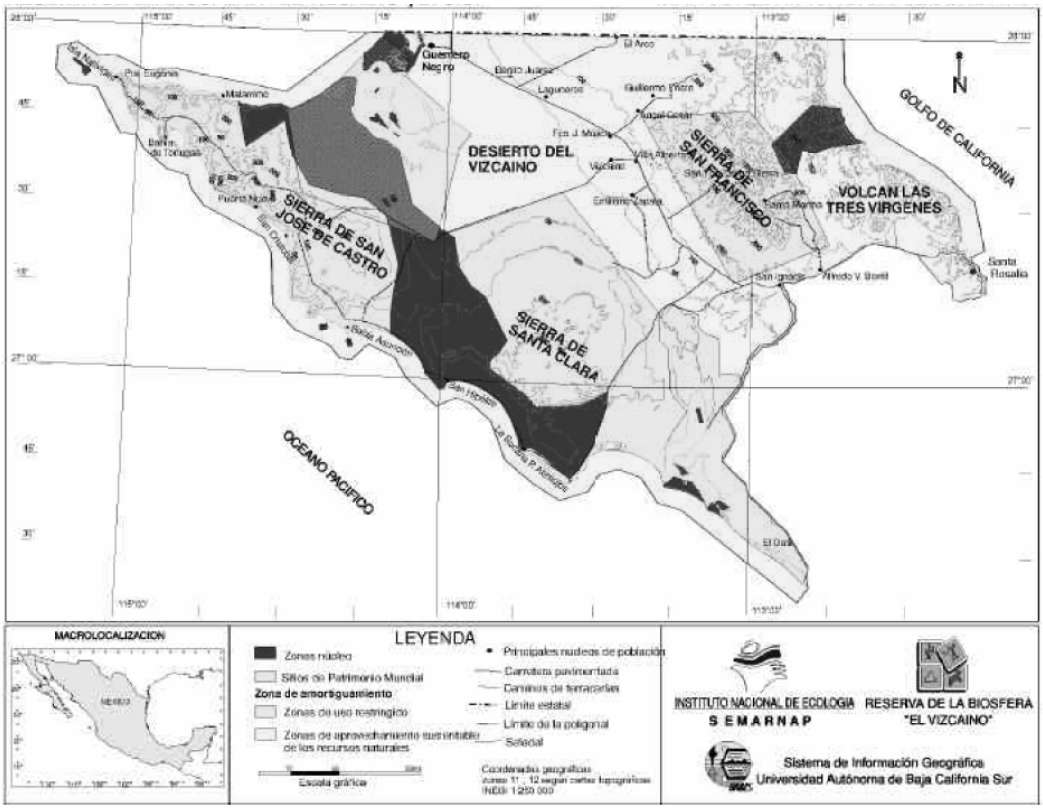

FIGURE 3: Map of the La Primavera Fauna and Flora Protection Area (BOSQUE). The small black square represents the site of the Cerritos Colorados geothermal field