NOTICE CONCERNING COPYRIGHT RESTRICTIONS

Legal Barriers to the Utilization of Geothermal Energy in Protected Areas of Costa Rica

Paul Moya[1], Emilia M. Rodríguez[2], and Alfredo Mainieri[1]

[1]Instituto Costarricense de Electricidad, UEN de Proyectos y Servicios Asociados
San José, Costa Rica
pmoya@ice.go.cr, almain@ice.go.cr
[2]Oficentro Plaza Mayor, San José, Costa Rica
emiliamaria@racsa.co.cr

Keywords

Geothermal energy in protected areas, legal barriers to geothermal energy, National Parks, Costa Rica

ABSTRACT

The Costa Rican Institute of Electricity (ICE) is in charge of the development and management of electric power generation in Costa Rica. ICE has developed the Miravalles geothermal project, which currently has an installed capacity of 163 MW, representing 15.4% of the total electrical energy produced in the country. Even though Costa Rica has considerable undeveloped geothermal resources (estimated at a minimum of 865 MW), most of this potential is located inside national parks. Current laws do not allow the exploration or exploitation of geothermal energy inside national parks, and thus the potential for future geothermal development of the country is very limited. A new bill, entitled "Regulation Law for Geothermal Energy Production in National Parks" (File No. 16,137), has been written and presented to the Costa Rican congress. Its main purpose is to authorize ICE to develop geothermal resources inside the national parks while maintaining their protection for future generations. There have been conversations with some of the new members of congress to acquaint them with this law, and they have shown their willingness to support it when it is discussed in the legislature.

Introduction

Increasing human needs and economic activity exert pressure on natural resources, causing conflicts between land use and environmental protection. Thus, integrated planning is required to establish a proper balance between social and economic development and the environment itself. This concept applies to energy development based on renewable as well as non-renewable resources.

In Costa Rica, the Instituto Costarricense de Electricidad (ICE), an autonomous organization of the Costa Rican Republic that manages every aspect of the production of electrical energy, has taken into account the environmental sustainability of each project to be developed, including hydro, geothermal, wind and even thermal developments. In each of these types of projects, ICE has tried to preserve the natural environment as much as possible.

Costa Rica is located in the southern part of the Central American isthmus, between Nicaragua and Panama (Figure 1). The country extends over an area of approximately 51,000 km^2 and has a population of about 4.3 million. In the early 1970s, Costa Rica satisfied its electricity needs using hydro (70%) and thermal (30%) energy sources. The continuous rise in oil prices, especially during the 1973 crisis, motivated ICE to study the possibility of using other energy sources for generating electricity, including geothermal energy (Moya, 2003).

In 1974, as a consequence of a steep increase in the price of petroleum and petroleum by-products, ICE opted to study numerous areas that are geologically favorable for the existence of geothermal resources that could be used for electricity production. Such resources are local, renewable and non-contaminating, making them an attractive alternative for hydrocarbon substitution in electricity generation.

In its pursuit of geothermal development in Costa Rica, ICE has identified areas of geothermal interest at the following volcanoes: Rincón de la Vieja, Tenorio, Pocosol, Cerro Pelado, Platanar-Poás, Barva and Irazú-Turrialba (Figure 1). All of these volcanoes except for Cerro Pelado are located inside protected areas such as national parks.

Costa Rican Geothermal Development

Preliminary studies have been completed on the Pacific slopes of the Miravalles, Rincón de la Vieja and Tenorio volcanoes. In each of these areas, extensive zones of important geological, geochemical, and geophysical anomalies associated with high temperature geothermal resources have been identified. With information obtained in 1979, ICE began developing the Miravalles geothermal field, where there are currently five power plants with a total combined capacity of

163 MW. The development and the importance of the Miravalles geothermal complex is described below.

Towards the end of the 1980s, a nationwide geothermal reconnaissance study was carried out in Costa Rica. This study resulted in the evaluation and quantification of national geothermal potential in terms of resource and reserves. Based on the information obtained, the country could be divided into three broad geothermal zones. The first is a zone of high-temperature resources greater than 180ºC at 2,500 m depth; see Figure 2. The second is a moderate-temperature zone, with a temperature range between 180ºC and 120ºC, and the third is a low-temperature zone, with temperatures of less than 120ºC, which is suitable only for direct-use applications.

In Figure 2 it can be seen that all of the high-temperature zones are associated with the northwest-southeast trending Costa Rican volcanic axis. When the studies were carried out, there were no limitations on access to these zones, because the legal constitution of protected zones was still at an early stage. With the exception of the Rincón de la Vieja National Park, formed in the late 1970s, there were no limitations on the exploration and future exploitation of geothermal resources within the high-temperature zones.

Costa Rica, located in the tropics, has a low level of industrial development. For this reason, interest has been placed on the utilization of high-enthalpy geothermal resources. Once the definition of the broader resource zones was completed, the geothermal potential was evaluated in the nine high-temperature zones shown in Figures 2 and 3. Table 1 shows the estimated installable thermoelectric capacity for each of these zones, based on the identified reserves for exploitation by both single-flash and double-flash methods.

As indicated in Table 1, there is a significant geothermal potential within protected areas. Nevertheless, since current laws do not allow anyone to explore for or exploit any type

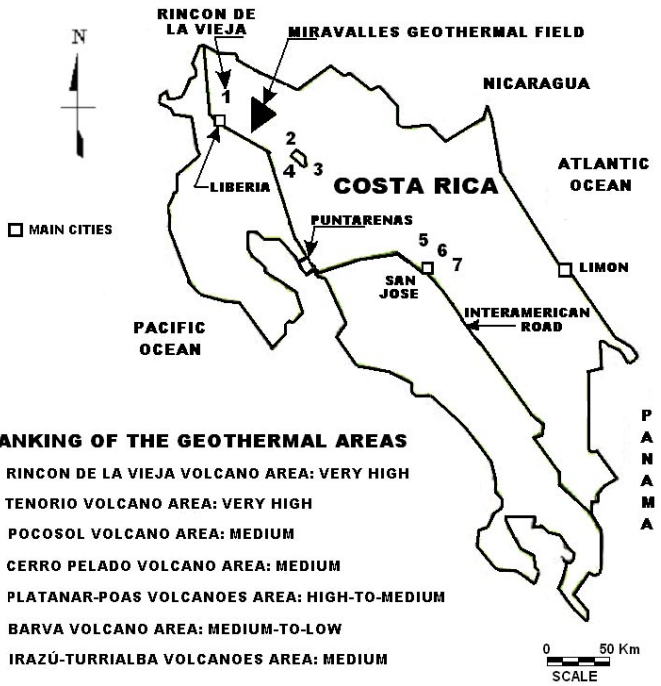

Figure 1. Location of geothermal areas in Costa Rica.

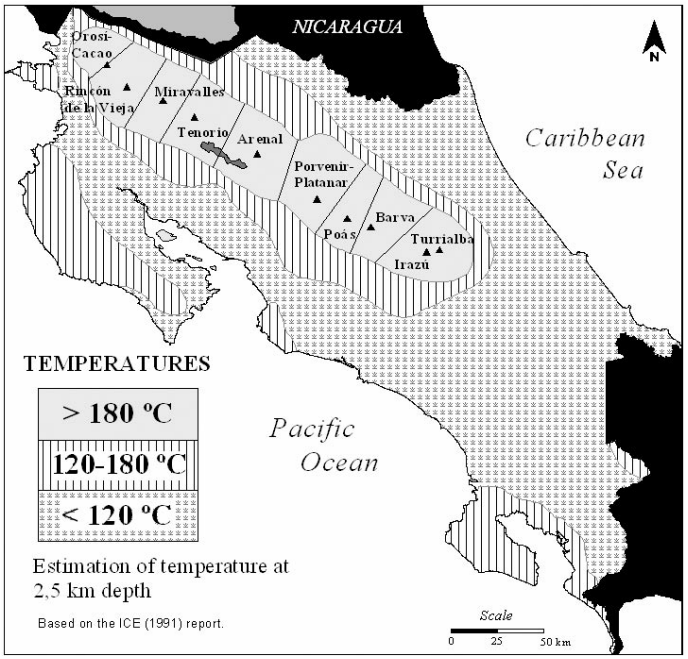

Figure 2. Temperature ranges for geothermal zones in Costa Rica.

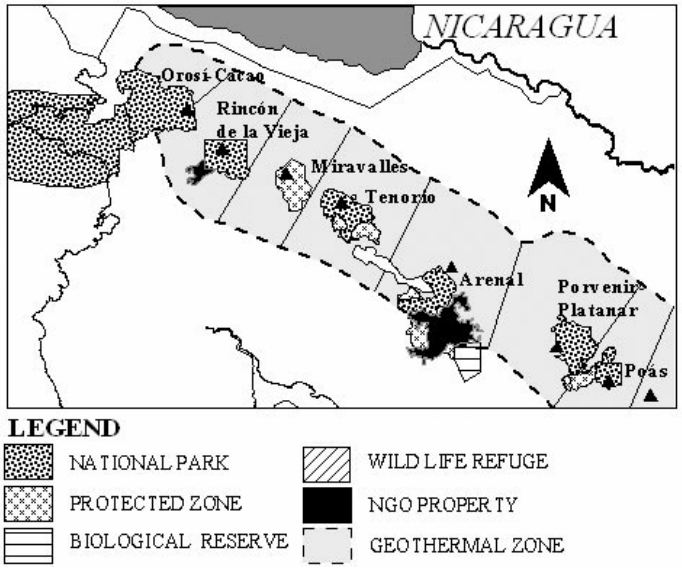

Figure 3. High-temperature zones.

Table 1. Estimated installable thermoelectric capacity.

Zone (Volcano)	Single-flash	Double-flash
Miravalles	164	213
Rincón de la Vieja	137	177
Irazú Turrialba	101	130
Tenorio	97	123
Platanar	97	122
Poás	90	116
Barva	85	109
Fortuna	61	77
Orosí-Cacao	33	41
TOTAL	**865**	**1108**

ICE, 1991.

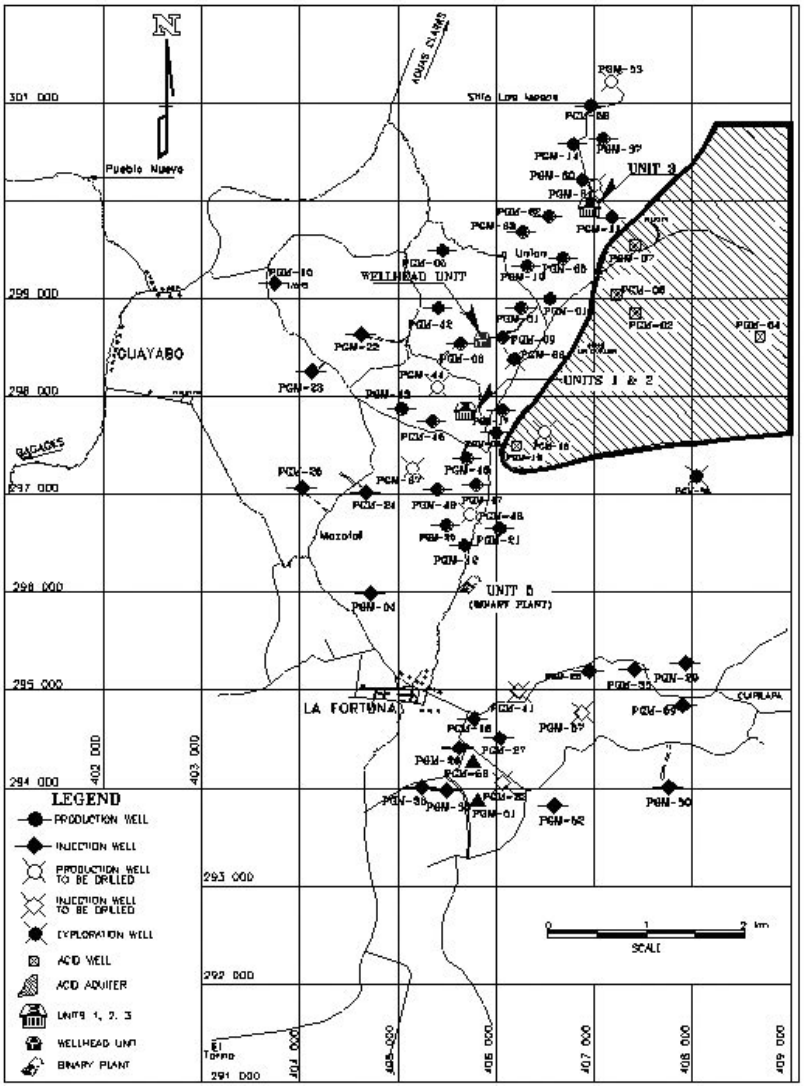

Figure 4. Map of the Miravalles geothermal field.

of energy inside the national parks, the future of geothermal development in Costa Rica is very limited.

Miravalles Geothermal Field

The Miravalles geothermal complex, the most important Costa Rican geothermal area, is located on the southwestern slope of the Miravalles volcano. The present field extends over an area of more than 21 km^2; about 16 km^2 are dedicated to production and 5 km^2 to injection. The temperature of the water-dominated geothermal reservoir is about 240°C. Fifty-three geothermal wells have been drilled to date (Figure 4). They include observation, production and injection wells, with depths ranging from 900 to 3,000 meters (Moya, 2003). Individual wells produce enough steam to generate an average of 7 MWe; injection wells accept between 70 and 450 kg/s of residual (separated) geothermal fluids each.

Commercial production of electricity using geothermal steam began at Miravalles in early 1994, when Unit 1, a 55-MW single-flash plant, was commissioned. The following year, ICE completed the installation of a 5-MW wellhead unit. Then, two temporary 5-MW wellhead plants came on line as part of an agreement between ICE and the Comisión Federal de Electricidad de México (CFE). The two temporary units were disassembled in January and August 1998 and returned to CFE. Unit 2, the second 55-MW plant, started production in August 1998. In March 2000, Unit 3, a 29-MW single-flash private plant, started delivering electricity to the national grid, and finally Unit 5, a 19 MWe binary plant, increased the total installed capacity at Miravalles to 163 MWe (Table 2). The location of the power plants is shown in Figure 4. The history of the growth of capacity at the field is shown in Figure 5 (Moya, 2005).

In Table 2, overleaf, the abbreviations stand for: ICE - Instituto Costarricense de Electricidad; CFE - Comisión Federal de Electricidad (México); WHU - Wellhead Unit; and BOT – build-operate-transfer.

Steam for Units 1-3 and the wellhead unit is separated from the produced hot water at seven separation stations. Generally, two or three production wells send their two-phase fluids to one of these stations. At present, separation stations 2, 3 and 4 supply steam mainly to Unit 1, stations 1, 5 and 6 feed Unit 2, and station 7 sends its steam to Unit 3 (Moya, 2005). Figure 6, overleaf, shows the amount of fluids handled by the seven separation stations since they began operation.

Currently, the total steam delivered to the power plants is about 300 kg/s. The mass produced from the reservoir since 1994 is

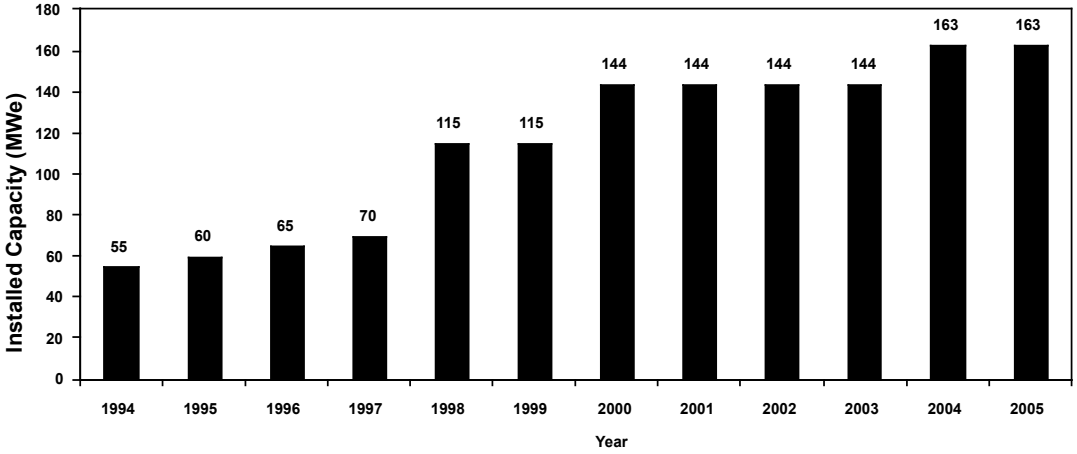

Figure 5. Costa Rica's installed geothermal power capacity: 1994 – 2005.

Table 2. Units at the Miravalles Geothermal Field.

Plant Name	Power (MW)	Owner	Start-up Date	Shut-down Date
Unit 1	55	ICE	3/1994	
WHU-1	5	ICE	1/1995	
WHU-2	5	CFE	9/1996	4/1999
WHU-3	5	CFE	2/1997	4/1998
Unit 2	55	ICE	8/1998	
Unit 3	29	ICE (BOT)	3/2000	
Unit 5	19	ICE	1/2004	

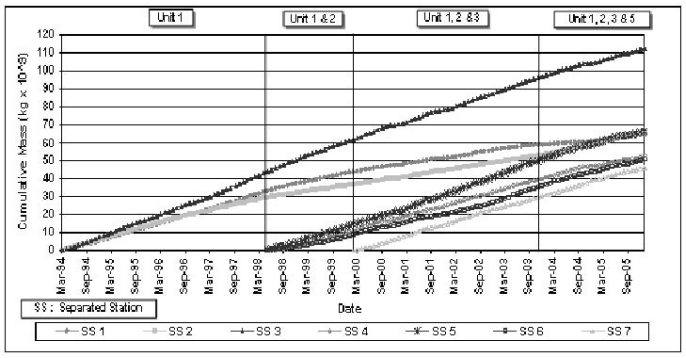

Figure 6. Cumulative fluid mass per separation station.

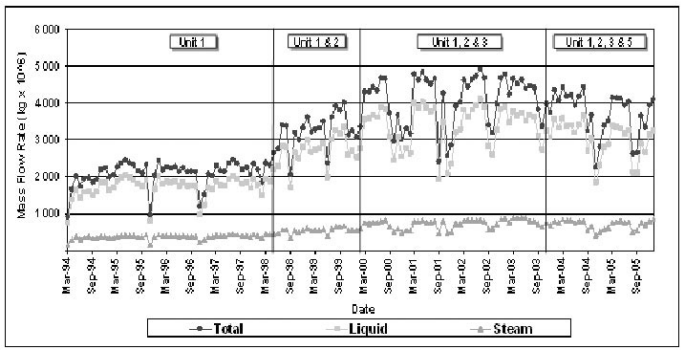

Figure 7. Mass Produced from the Miravalles Geothermal Field.

shown in Figure 7. Incremental production increases have accompanied each of the new units coming on line. Around 1,250 kg/s of residual (separated) geothermal water is sent to the injection wells, which are distributed in four areas of the field, i.e., the northern, southern, eastern and southwestern sectors (Figure 8).

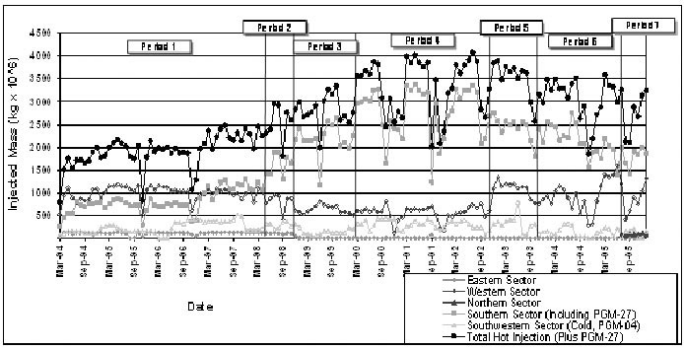

Figure 8. Mass Injected into Different Sectors of the Miravalles Geothermal Field.

Unit 5 (a 19 MW binary plant) was commissioned in January 2004 and increased the installed geothermal capacity at Miravalles to 163 MW. Unit 5 extracts additional energy from the separated geothermal brine before it is injected back into the geothermal reservoir.

Based on data from eleven years of commercial exploitation, as well as numerical modeling studies, ICE has decided to defer the installation of additional flash units in the known 21 km^2 geothermal area. A new exploratory well, located to the east of the principal production zone, was completed in February 2003 and will provide additional steam to supplement that from the main production zone. No increase in the installed geothermal capacity is foreseen within the next few years unless a new reservoir is found.

The Importance of Geothermal Electricity Generation for Costa Rica

Table 3 presents the contribution of different energy sources to the Costa Rican electricity system for the years 2000-2004. Most of the installed capacity corresponds to hydro, and smaller amounts to fossil fuel (bunker and diesel), geothermal (all at Miravalles) and wind. Table 3 also shows the amount of electricity generated during these years.

Concurrent with the growth in installed capacity at Miravalles (Figure 5), there was an even more important increase in the amount of electricity generated (Figure 9). Between 1994 and 2004 the installed capacity at the field grew from 55 to 163 MW (a 196% increase), while generation grew from 341 to 1,204.4 GWh (a 253% increase).

The high availability of geothermal plants is illustrated by the figures shown in Table 3. Even though the installed capacity at Miravalles is only 8.6 percent of the country's total (as of 2004), it produced more than 15 percent of the electricity generated. For Miravalles the load factor was 86.5% (year 2004), the highest of all types of power plants installed in the country.

Future Geothermal Development in Costa Rica

For many decades now, the government of the Costa Rican Republic has been applying strict environmental protection policies. As a result of this, many protected areas have been created within the following seven categories: National Parks, Forest Reserves, Protected Zones, Biological Reserves, Natural

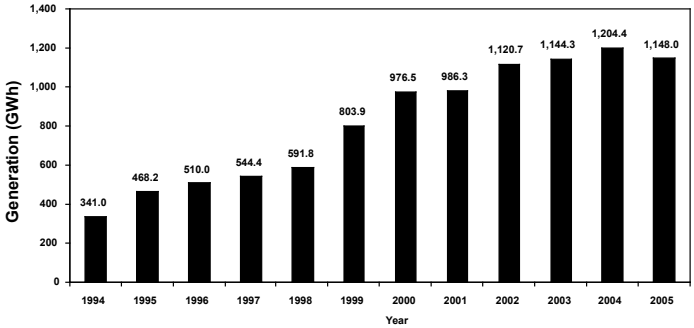

Figure 9. Geothermal energy generation in Costa Rica: 1994 – 2005.

Table 3. Costa Rica Electrical System: 2000-2004.

Year: 2000

Source of Energy	*Installed Capacity (MW)	Installed Capacity (%)	Generated Electricity (GWh)	Generated Electricity (%)	Load Factor (%)
Hydro	1,213.5	74.5	5,690.6	82.3	53.5
Thermal	229.0	14.0	64.4	0.9	3.2
Geothermal	142.0	8.7	976.5	14.1	78.5
Wind	46.2	2.8	182.7	2.7	45.1
Total	1,630.7	100.0	6,914.2	100.0	

Year: 2001

Source of Energy	*Installed Capacity (MW)	Installed Capacity (%)	Generated Electricity (GWh)	Generated Electricity (%)	Load Factor (%)
Hydro	1,229.5	74.2	5,658.2	81.7	52.5
Thermal	240.0	14.5	100.0	1.4	4.8
Geothermal	141.4	8.5	986.3	14.2	79.6
Wind	46.2	2.8	185.5	2.7	45.8
Total	1,657.1	100.0	6,930.0	100.0	

Year: 2002

Source of Energy	*Installed Capacity (MW)	Installed Capacity (%)	Generated Electricity (GWh)	Generated Electricity (%)	Load Factor (%)
Hydro	1,229.5	73.5	5,983.6	79.9	55.5
Thermal	240.0	14.3	127.6	1.7	6.0
Geothermal	141.2	8.5	1,120.7	15.0	90.6
Wind	62.2	3.7	258.4	3.4	47.4
Total	1,672.9	100.0	7,490.3	100.0	

Year: 2003

Source of Energy	*Installed Capacity (MW)	Installed Capacity (%)	Generated Electricity (GWh)	Generated Electricity (%)	Load Factor (%)
Hydro	1,240.5	69.6	6,022	79.6	55.4
Thermal	334.0	18.7	169	2.2	5.8
Geothermal	141.2	7.9	1,144	15.1	92.6
Wind	68.6	3.8	230	3.1	38.2
Total	1,784.3	100.0	7,565	100.0	

Year: 2004

Source of Energy	*Installed Capacity (MW)	Installed Capacity (%)	Generated Electricity (GWh)	Generated Electricity (%)	Load Factor (%)
Hydro	1,283	69.6	6,295.3	80.5	56.0
Thermal	334	18.1	66.5	0.8	2.3
Geothermal	159	8.6	1,205	15.4	86.5
Wind	68.9	3.7	257.2	3.3	42.6
Total	1,844.9	100.0	7,824	100.0	

Note: *Installed Capacity (MW) = Installed Capacity authorized by ICE (MW).

Wildlife Refuges, Wetlands, National Monuments and Non-Governmental properties (NGOs). In all, the areas included in these seven categories comprise 25% of national territory. In some categories, and abiding varying levels of restriction, the law permits exploration and the eventual exploitation of the energetic and mineral resources available within them. However, the most stringent level of protection applies to the national parks, where the best geothermal and hydroelectric prospects are located. By law, all activity related to geoscientific studies and the eventual exploitation of energy resources in these areas is prohibited.

Figure 3 shows how the different protected zones coincide with the high-temperature geothermal areas. With the exception of Miravalles, which was developed before the formation of the Miravalles Protected Zone, none of these high-temperature zones can be used for the development of geothermal energy.

The formation of numerous national parks and protected zones has therefore inhibited the utilization of existing geothermal resources in previously located high-temperature zones. These restrictions are unproductive for the country because the production of electricity depends primarily on two energy sources: hydroelectric and geothermal, which accounted for 80.5% and 15.4% of the total electricity produced in the country in 2004, respectively, with the other 4.1% being obtained from wind and thermal sources.

The electricity produced by geothermal plants is placed at the base of the system to use it as a substitute for petroleum by products. It benefits the environment by producing only a fraction of the CO_2 and H_2S per generated kilowatt-hour than a thermal plant. The investigation and exploitation of geothermal energy for the production of electricity is an activity that can coexist with the concept of protected zones because, in addition to the benefits mentioned, once the construction phase is complete there is ground remediation in the surrounding areas as well as forest regrowth.

Legal Framework

Every human activity is regulated by norms (moral, ethical, religious and others), and, within these norms, laws are essential to live in a just society. As societies change for several reasons, laws change in order to take into account the transformation and modifications of legal regulations required by society.

In Costa Rica and some other countries, the current laws do not allow the exploration or exploitation of geothermal resources inside national parks. Perhaps this why the Geothermal Energy Association, in its publication "Geothermal Energy: Reliable and Clean Energy for the Americas", indicates that "the exploitation of geothermal energy and other renewable energies are insufficiently utilized" (1). It is therefore necessary to initiate a national (and perhaps also an international) discussion to send this topic to the respective legislatures of the countries with similar restrictions. In our case, it is urgent that the Costa Rican legislature is alerted to the contemporary social demand for clean and renewable energies.

Numerous international instruments, which have been certified by many countries around the world, have indicated the necessity to preserve the environment. The current Costa Rican internal legislation, in order to protect the environment, is limiting the possibility of exploiting geothermal energy. Paradoxically, this energy source offers many environmental advantages over other types of energies.

Under the currents laws, the increasing energy demand in Costa Rica can be satisfied only by utilizing thermal energy, because ICE is not allowed to develop hydro or geothermal

projects due to numerous legal restrictions. Examples of some of the Costa Rican laws that have led to this situation are:

1. National Park Law: this law prohibits any commercial, industrial or agricultural activities inside national parks; electrical generation, which is an industrial activity, is prohibited;
2. Forest Law and Environment Law: these are also rigid legislations in the sense that they restrict activities in national parks, biological reserves, mangrove swamps, protected zones, wildlife refuges and forest reserves. These laws give the Ministry of Environment and Energy the authority to "prevent or eliminate as soon as possible, the usage or occupation in the total area, in order to maintain a respect for the ecological characteristics … which have determined their establishment" (2).

The lack of flexibility in the Costa Rican legislation has led the Attorney General of the Republic to state several times that "current Forest Law can be considered practically an absolute protection of all natural territory in Costa Rica" (3).

Environment and Geothermal Energy: Two Concepts that are Compatible

Even though in many countries there are laws and regulations intended to prevent the abuse (or improper utilization) of natural resources, there has been abuse of natural resources, and therefore, there is a threat that these may be damaged for all mankind. Therefore, each country must develop its natural resources sustainably and responsibly. The world has begun to talk about "the age of renewable energy", in order to implement a new industrialization model. The fossil fuels age should come to an end and new, efficient technologies of producing energy should be implemented: "a greater use of the geothermal energy will supply citizens with the opportunity of obtaining an effective control of their own energetic resources and also to utilize a domestic source, which is stable and secure" (4).

The "social function" of natural resources should not be overlooked. Protecting the environment does not mean inhibiting its rational use. The equilibrium between nature and human beings should be addressed politically, in order to improve the quality of sustainable life.

A Legal Proposal

As indicated in the previous sections, the Costa Rican legal regulation of geothermal energy exploitation limits its development. For this reason, it is necessary to introduce new legislation that will comprise all the phases of geothermal energy production, taking into consideration all environmental concerns and at the same time eliminating the prohibition on geothermal energy production within National Parks.

A new bill (File No. 16,137) has been written and presented to the Costa Rican congress. It is entitled: "Regulation Law for Geothermal Energy Production in National Parks". The main purpose of this new bill is to authorize ICE to develop the geothermal resources inside national parks while retaining sensitivity and concern for environmental issues. In all the preliminary studies and final phases of any geothermal development, the principles of environmental sustainability must be respected, as well as the continued environmental improvement in the potential area of interest. The new law assigns to the "Secretaría Técnica Ambiental (SETENA)" the oversight of any possible geothermal development, in order to assure that these principles are being followed correctly.

A technical description of the main aspects of geothermal development (production and injection wells, pipelines, separation stations, power house, etc.) is included in the bill. Also, an environmental fee is established in order to pay for the use of the geothermal resource inside the national park. This fee is very important, because it represents a direct financial aid to the national parks to improve tracks and services for tourists, houses for forest rangers, fences, internal roads, etc.

Another issue considered in the new bill is directional drilling, which must be implemented to minimize the number of drilling sites. In addition to all this, before a geothermal project can be developed, an environmental impact study must be approved (as is now the case for any new project outside national parks), in order to identify and mitigate all possible environmental impacts in the area of interest.

In summary, some positive aspects of the new bill are:

1. The law facilitates the use of clean energy sources such as geothermal energy that are not utilized today due to legal restrictions, while helping to meet the country's constantly growing energy demand.
2. The law takes into account all environmental concerns inside the national parks, and obliges ICE to use all available techniques to mitigate any possible visual, audible, atmospheric and hydraulic pollution, as well as any impact on the flora and fauna inside the national park.
3. Oversight by SETENA in the process of exploration, development and exploitation ensures that environmental impacts on the national parks will be minimized. If pollution occurs in any of these phases, SETENA may deny permission to continue the geothermal development, with no right of appeal by ICE.
4. The environmental fee (0.1% of the value of the energy produced inside the national park) provides financial aid to the national parks. The fee can be paid in cash or in construction materials to improve the facilities inside the parks.
5. Directional drilling will be implemented to reduce the number of drilling sites required, and thereby reduce the environmental impact inside the national park.
6. Only the facilities necessary to develop the field will be allowed inside the national park. The law obliges ICE to remove any facility that is not strictly necessary during exploration and exploitation. This is done in order to maintain the park in as close to a pristine condition as possible.
7. All activities taking place inside the national parks, from exploration to exploitation, can be verified in a public file. This also guarantees the transparency of the whole process.

8. For the exploration phase, ICE is restricted to evaluating the geothermal potential by drilling no more than ten geothermal wells.
9. ICE´s environmental principles as well as continuing environmental improvements are fundamentally embodied in the bill. In the event of environmental damage, ICE is forced to repair it, following the parameters of the Environmental Law.

In Costa Rica, the congress and the president are elected for four years. On May 1, 2006, the newly elected members of congress will begin their term. There have been conversations with some of the new representatives to inform them of this law and its importance to Costa Rican geothermal development. In these conversations, representatives have suggested that they are willing to support the new law when it is discussed in congress.

Summary

Integrated planning is required to establish a relationship between social and economical developments and the environment, in which countries base their energy development on their own renewable energy possibilities. This concept applies to energy development based on renewable as well as non-renewable resources.

In the late 1980s a nationwide geothermal reconnaissance study resulted in the evaluation and quantification of Costa Rica's geothermal potential in terms of resources and reserves. When this study (and some others) were carried out, there were no limitations or restrictions on the access to resource areas because the legal constitution of protected zones was still in an early stage. With the exception of the Rincón de la Vieja National Park, formed in the late 1970s, there were no legal barriers to exploration and future exploitation of geothermal energy in identified zones of high-temperature resources.

There is a substantial geothermal potential located inside protected areas. Nevertheless, because current laws do not allow anyone to explore or exploit any type of energy inside the national parks, the future of geothermal development in Costa Rica is very limited.

The formation of numerous national parks and protected zones has had a negative impact on geothermal development, because it inhibits the utilization of existing geothermal resources in previously located high-temperature zones. These restrictions are unproductive for the country, since the production of electricity depends primarily on two energy sources: hydroelectric and geothermal, which in 2004 provided 80.5 and 15.4% of the total electricity produced in the country, respectively.

The "social function" of natural resources should not be overlooked. Protecting the environment does not mean inhibiting its rational use. The equilibrium between nature and human beings should be addressed politically, in order to improve the quality of sustainable life.

A new bill (File No. 16,137) has been written and presented to the Costa Rican congress; it is entitled: "Regulation Law for Geothermal Energy Production in National Parks". The main purpose of this new bill is to authorize ICE to develop the geothermal resources inside national parks in an environmentally sensitive manner.

The law takes into account all environmental concerns inside the national parks, and obliges ICE to use all available techniques to mitigate any possible visual, sonic, atmospheric and hydraulic pollution, as well as any impact on the flora and fauna inside the national park.

Oversight by SETENA in the process of exploration, development and exploitation ensures that environmental impacts on the national parks will be minimized. If pollution occurs in any of these phases, SETENA may deny permission to continue the geothermal development, with no right of appeal by ICE.

The environmental fee (0.1% of the value of the energy produced inside the national park) provides financial aid to the national parks. The fee can be paid in cash or in construction materials to improve the facilities inside the parks.

There have been conversations with some of the new members of congress to inform them of this law, and they have shown their willingness to support the new law when it is discussed in congress.

Acknowledgements

The authors thank Roger Henneberger (GeothermEx, Inc.) for editing and improving the manuscript.

References

Moya, P., 2003, "The Costa Rican Geothermal Energy Development," *The IERE Central America Forum Transnational Electrical Interconnections and Sustainability in Central America*, Session 2, November 24-25, 2003. San José, Costa Rica.

Moya, P., Yock, A., 2005, "First Eleven Years of Exploitation at the Miravalles Geothermal Field" *Proceedings, Thirtieth Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California*, January 31-February 2, 2005.

Instituto Costarricense de Electricidad y Asamblea legislativa. "Energía Geotérmica en Parques Nacionales: barreras y oportunidades". Simposio. Exposiciones del Lic. Henry Campos y del Dr. Alfredo Mainieri. 13 de octubre de 2005. San José, Costa Rica.

ICE, 1991. "Evaluación del Potencial Geotérmico de Costa Rica", *Resumen Ejecutivo*, Instituto Costarricense de Electricidad, Noviembre 1991, San José, Costa Rica.

Department of Environment & Natural Resources, 2002. "Implementing rules and regulations of the Republic Act. No. 9154 on the Mount Kanla Natural Park (MKNP), Act. of 2001", Series of 2002.

(1) Geothermal Energy Association, "Geothermal Energy: Reliable and Clean Energy for the Americas". Page 2, www.geo-energy.org/publications/reports.

(2) Environmental Law No. 7554, Article 34, October, 4th, 1995, San José, Costa Rica.

(3) Attorney General of the Republic, Resolution C-103-988, July, 1998.

(4) Garman, David K. Geothermal Today, U.S. Department of Energy, "La energía geotérmica en la actualidad", Geothermal Technologies Program Highlights, Energy Efficiency and Renewable Energy, page 3, 2003.