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Costa Rica Country Update Report

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ABSTRACT

From the last country update report, which was presented during the 2000 Kyushu-Tohaku congress, the geothermal development and exploitation have fully continued at Miravalles the only costarican productive geothermal field. At the end of this period the installed power at Miravalles was the 8.4 % of the total electrical capacity of Costa Rica republic and the energy produced by Miravalles system, during the same year, represented about the 15.1 % of the total energy produced. When the fifth unit came on line at the end of 2003 the total installed capacity reached 162.5 Mw. In this field, additional studies carried out were successfully completed and a new productive area was discovered east of the zone under exploitation. During the quinquenniun covered by this report, the utilization of the small acid reservoir, located in the northeast sector of the field and used as a complementary source of steam, successfully continued as well as a second acid well which was added to the main steam production system. In the near future two more acid wells will be added to the steam production system.

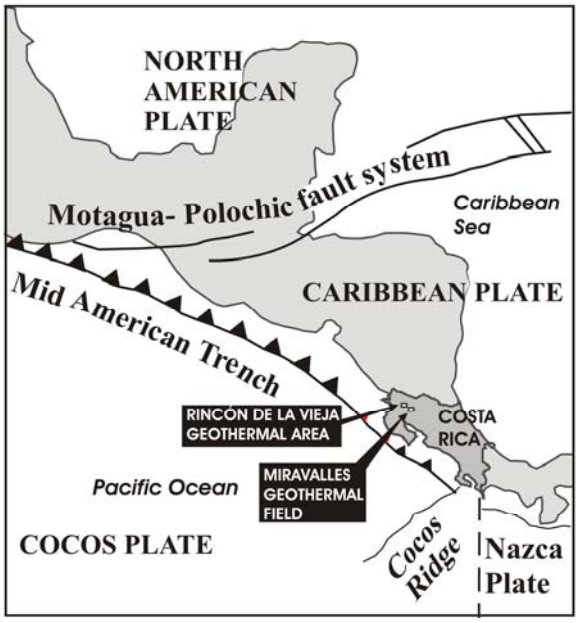

Figure 1: Location of the Rincón de la Vieja Geothermal Area and the Miravalles Geothermal Field.

The studies carried out at Rincón de la Vieja were successfully completed when a productive high temperature reservoir was located at Las Pailas field, and a first 35 MW plant feasibility report was presented. Based on the national electrical development program, this unit will be online during 2010. Also at Rincón de la Vieja volcano, in the area called Borinquen, the feasibility studies are being carried out. The drilling campaign allowed the localisation of a productive zone with the higher geothermal temperature found until now. The direct-use of the geothermal energy just began as a few swimming pools. No other direct-uses are reported.

1. GENERATION SYSTEM

The available electricity generation system in the Costa Rican Republic is based on developmental programs oriented mainly towards the utilisation of the country's domestic renewable natural resources. This program is the result of a plan based upon the utilisation of domestic renewable resources, which has been applied since the second half of the past century. Costa Rica, with a territory of approximately 51,000 km^2, located at the extreme southeast of the Central American isthmus, is the smallest Central American Republic, next to El Salvador. Due to the particular configuration of its territory, its high mountain belt and high annual precipitation, Costa Rica has very favourable conditions for the construction of hydroelectric plants. As a matter of fact, this resource is the country's main electricity production source. Only during the year 2003, hydroelectric plants provided 79.6% of the total electricity produced by the country and, with small variations in the 2000-2004 quinquenium, were the main source of electric energy production. During the year 2003, the plants installed at the Miravalles Geothermal Field (figure 1), whose capacity at that time was equivalent to 8.4% of the total installed capacity, generated 15.1 of the total energy produced in the country. During this same period, geothermal energy was the second most important electricity generation source, which is why its contribution to the national economic panorama was of great importance, permitting a marked reduction on the importation of petroleum by-products which would have been necessary for the operation of thermal plants. Also in 2003, the renewable cycle electric plant system (wind and biomass) equivalent to 4.3 of the available installed capacity, provided 3.2 of the energy produced. Finally, the conventional thermal plants, equivalent to 17% of the installed capacity, which operate mainly as a reserve for the electrical system, provided the remaining 2.1%.

In figures 2 and 3 the distribution of the installed capacity, by source, and energy produced are shown for the year 2003.

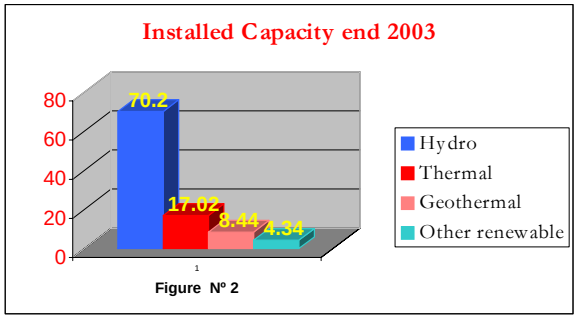

Figure Nº 2

Figure 2: Total installed capacity, by source, at the end of 2003.

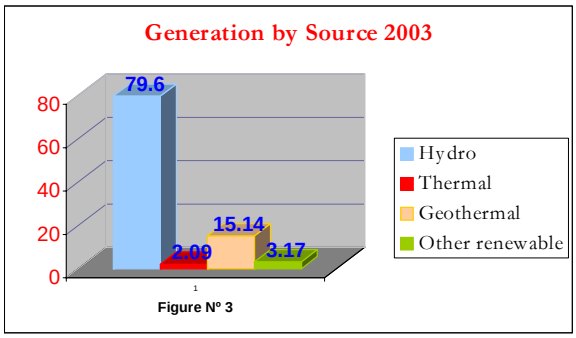

Figure 3: Total electricity generation, by source, in 2003.

2. MIRAVALLES GEOTHERMAL FIELD

With the incorporation of Miravalles V, in December an 18 Mw plant which operates on a binary cycle, the installed capacity in the field reached 162.5 Mw. Based on the mathematic reservoir models and physio-chemical log of the permanently extracted fluids, the acquired information indicates that this new unit in the field reached its maximum installable capacity that the known reservoir can maintain continuously during its useful life. Historically, electricity generation in Costa Rica from a geothermal reservoir began in 1994, when the first 55 Mw unit was commissioned. Then, in the beginning months of 1995, a small 5 Mw backpressure unit was added to the system. In 1998 the installed capacity increased considerably when a second 55 Mw unit came online. Finally, in the year 2000, a 29.5 Mw plant was put into operation (see table No. 2). With the exception of the 29.5 Mw plant, which operates supported by a 15 year BOT contract, the plants are property of and operated by the Instituto Costarricense de Electricidad, the only public entity permitted by law to investigate, develop and exploit geothermal energy. At the Miravalles Geothermal Field, located on the flank of Miravalles volcano, a water dominated reservoir with an average temperature of 240°C, subdivided based on the chemistry of fluids produced in the main, neutral pH reservoir, located in the north and central part of the field, and a secondary, low pH reservoir of lesser extension, with pH values between 2.2 and 3.5, located in the extreme northeast of the field, is exploited for electricity production (figure 4).

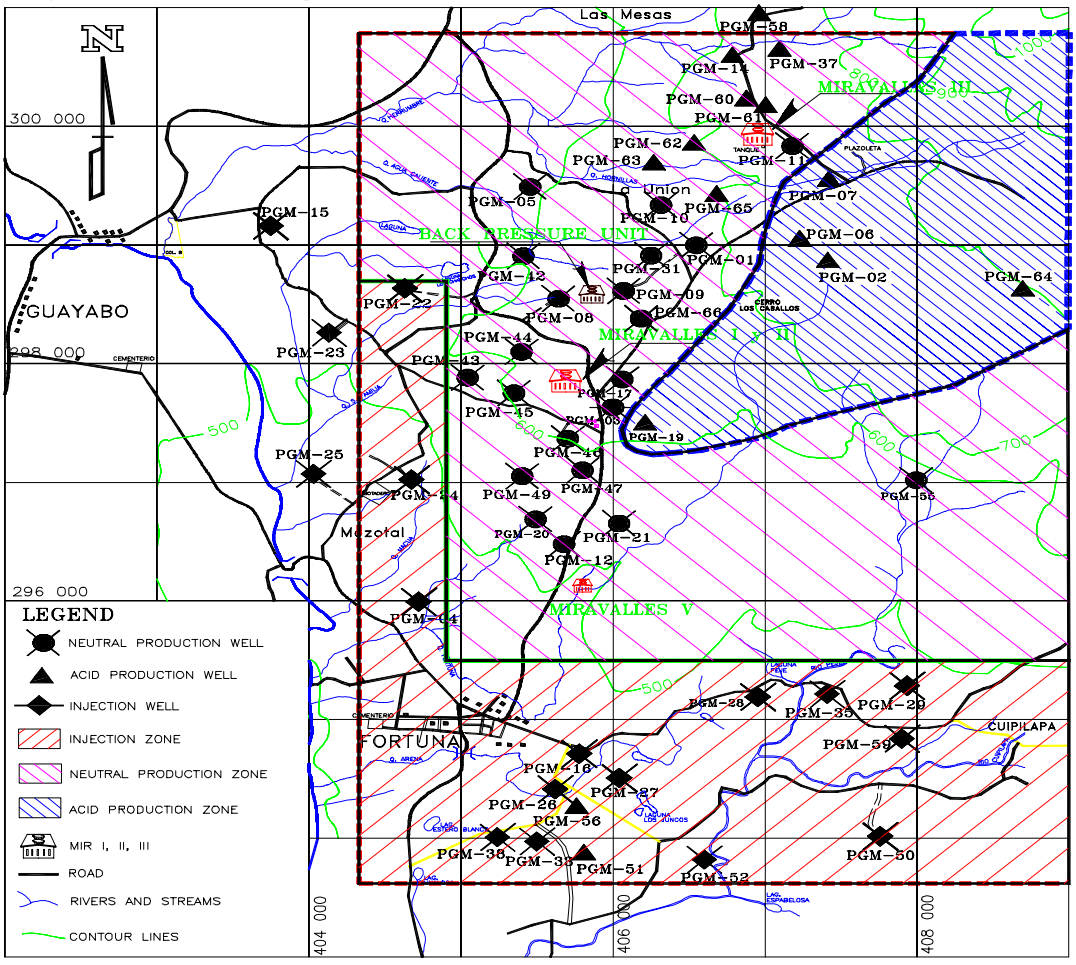

Figure 4: Injection zone, neutral production zone and acid production zone at the Miravalles Geothermal Field.

In all, 52 deep wells have been drilled, of which 32 are production wells and 14 are used for gravity injection of residual waters in two different areas, the primary one located to the south and a secondary one to the west of the production area. Six wells were drilled as part of the field's expansion to explore and define the extension of the reservoir. Of the 32 production wells, 28 produce fluids from the main, neutral pH, reservoir whereas four produce fluids from the secondary, low pH, reservoir. To date, the physio chemical controls utilised indicate that the reservoir

responds to the exploitation in accord with estimated values. With chemical logs, which have been carried out since the field began industrial operation, it has been confirmed that the gravity driven injection of residual waters plays a dominant role in reservoir recharge. Once sufficient reliable information had been accumulated, from indirect prospecting, to establish the northern, southern, and western boundaries of the field, and confirm the presence of favourable underground conditions for the extension of the reservoir under exploitation towards the eastern sector of the field, a drilling campaign was programmed to confirm the possibility of expanding the production zone in this direction.

The hypothesis of whether or not in the eastern sector there is a new commercially exploitable production reservoir, for electricity generation, or an extension of the one currently being exploited, was confirmed by drilling well PGM-55, which produces 5 Mw of power and provides evidence of a resource with similar temperature and chemistry as the main reservoir. Investigations are underway to determine the amount of hydraulic connectivity with the rest of the field. This new zone will be used as a steam reserve for the operation of the existing plants. As part of ICE's policy with all of its plants, which attempts to preserve the environment, the wells programmed in the eastern sector of Miravalles will be drilled using currently existing drilling platforms.

3. RINCÓN DE LA VIEJA GEOTHERMAL AREA

As a result of prospects to locate the existence of new geothermal fields, which have been carried out at the Rincón de la Vieja volcanic complex, located at the extreme northwest of the Guanacaste volcanic belt, sufficient information for locating two important zones, named Las Pailas and Borinquen, approximately 8 km from one another on the southern flank of the aforementioned volcano, important results have confirmed the existence of a high temperature production geothermal reservoir at Las Pailas. Feasibility studies currently underway at Borinquen, although still in beginning stages, indicate promising possibilities of success. These studies will allow a ready determination of whether or not there are two separate geothermal areas or if they share the same reservoir.

Figure 3: Rincón de la Vieja Geothermal Area

4. LAS PAILAS GEOTHERMAL FIELD

Having obtained the respective environmental permits, in January of 2000 the first exploratory well and feasibility studies for Unit 1, which ICE plans to have online by the year 2010, began. The area covered during the feasibility study corresponds to a narrow zone located between the Blanco and Colorado rivers. (see fig. No. 5) Part of the feasibility study included drilling five exploratory wells, three of which confirmed the existence of a geothermal reservoir with temperatures near 260°C, moderate salinity and a low non-condensable gas content located in a southeast-northwest striking structure which is aligned with the volcanic axis. The mathematic model indicates that the reservoir is capable of providing enough steam necessary to operate the first 35 Mw unit.

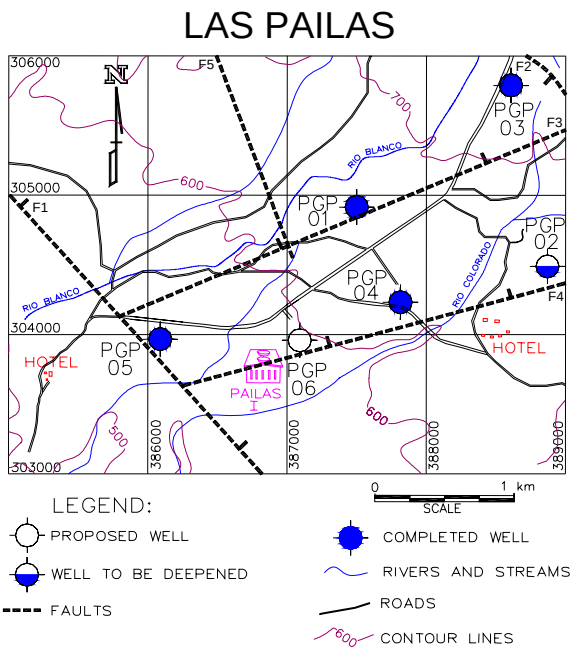

Figure 5: Las Pailas Geothermal Field.

5. BORINQUEN GEOTHERMAL PROJECT

Once the wells for the feasibility study in Las Pailas had been drilled, the first exploration well was begun at the Borinquen project (see fig. 6), located at the northwestern extreme of the area under exploration at the Rincón de la Vieja volcanic complex. This is the first of four wells programmed as part of the feasibility study for the first unit planned to be constructed in this area, and is still being drilled. The information that has been obtained thus far confirms the presence of the important thermal anomaly measured in Las Pailas, associable with the magma chamber of the Rincón de la Vieja volcano. The finalisation of the feasibility studies underway is estimated for the second half of the year 2005.

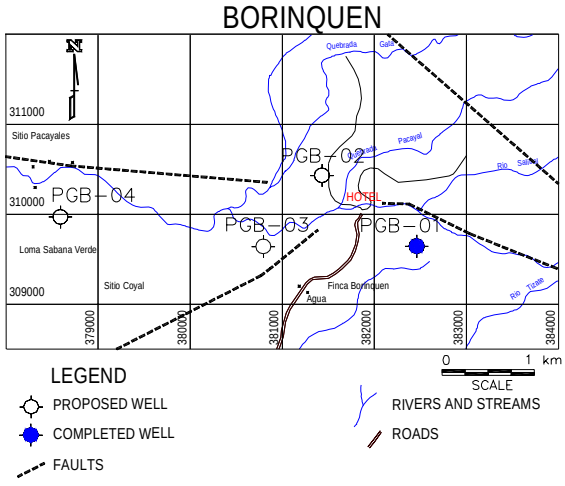

Figure 6: Borinquen Geothermal Project.

6. DIRECT USE

To conclude with other applications, it is important to add that with respect to other uses of geothermal energy, since the end of the 1980's and with the help of the Italian government and the U.N.D.P. (United Nations Development Program), a study of the country's territory

was completed, in which various zones of important moderate and low temperature resources were located. Even though there were favorable results from this study, there has not been any development of the use of these resources. In this regard, one must take into consideration local factors

where, due the geographic location of Costa Rica, between 9 and 11 degrees north latitude, there area very favorable climatic conditions associated with incipient industrial development of geothermal resources and a lower range and usefulness of the application of this type of resource for example in greenhouses and warming of buildings, as a matter of fact, currently the use of this type of resource is limited to low temperature forms in mountain hotel pools dedicated to ecological tourism. In summary, currently, with the exception of small domestic applications, other uses are not known of.

TABLE 1. PRESENT AND PLANNED PRODUCTION OF ELECTRICY (Installed)

	Geothermal		**Fossil Fuels**		**Hydro**		**Nuclear**		**Other Renewables** (specify)		**Total**	
	Capacity Mwe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity Mwe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity Mwe	Gross	Capacity MWe	Gross Prod. GWh/yr
In December er 2003	162.5	1145	328	158	1352	6022	0	0	83.5 (1)	240	1926	7565
Under In December er 2003	None	None	None	None	379	1688 (3)	None	None	None	None	379	1688 (3)
Funds but not yet construction December	35	292 (3)	199	96 (3)	None	None	None	None	33 (2)	95 (3)	267	483 (3)
Total use by	197.5	1437	527	254	1731	7710			116.5	335	2572	9736

(1) 62 mw wind 19.5 mw biomass (2) wind (3) Planned

TABLE 2. UTILISATION OF GEOTHERMAL ENERGY FOR ELECTRIC POWER GENERATION AS OF 31 DECEMBER 2004

F=Single Flash B= Binary

Locality	Power Plant Name	Year Com-missioned	No. of Units	Status	Type of Unit	Total Installed Capacity MWe	Annual Energy Produced (2003) GWh/yr	Total Under Construction or planned Mwe
Miravalles	Miravalles I Miravalles II Miravalles III Miravalles V Boca de Pozo	1993 1998 2000 2003 1995	1 1 1 1 1		1F 1F 1F B 1F	55 55 29.5 18 5	450 437 224 7 27	
Rincón de la Vieja	Las Pailas	2010	1		1F			35
Total						**162.5**	**1145**	**35**

Table 3. Wells drilled for direct electrical use of geothermal resources up to December 2004

Purpose	Wellhead Temperature	Number of Wells Drilled				Total Depth (km)
		Electric Power	Direct Use	Combined	Other (specify)	
Exploration[1)]	(all)	**82**				**38.4** **66.4**
Production	>150 °C	**35**				
	150-100°C					
	<100° C					
Injection	(all)	**14**				**23**
Total		**131**				**123.8**

REFERENCES

Instituto Costarricense de Electricidad, El Sector Eléctrico Nacional, Oct 2003

[1)] Include thermal gradient wells, but not ones less than 100 m deep.