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Costa Rica Country Update Report

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ABSTRACT

During the last five years, when the Costa Rica country update report was presented at Antalia Turkey, Costa Rica´s geothermal frame remains mainly the same. In other words, the geothermal exploitation is still based upon the five units installed at Miravalles, currently the only Costa Rica productive geothermal field.

Miravalles, continues to have a high energy production rate. During this five year period, after the Antalia congress, the five units installed at Miravalles reached a 165.5 Mw, equivalent to 8% of the total electrical capacity of Costa Rica republic and produces about the 13% of the total energy produced by the Costa Rica electrical system.

During the quinquenniun covered by this report, the endogen steam used at Miravalles has mainly comes from a neutral reservoir, although about 24 Mw are available from the Miravalles acid reservoir, located in the northeast sector of the field, and is used as a complementary source of steam. From the acid reservoir a total of four acid wells were added to the main stream production system.

At Pailas geothermal field a first 41 Mw binary plant is under construction. This plant will be on line in the second half of 2011. Also at the Rincon de la Vieja volcano, in a second area called Borinquen, a first plant feasibility studies are being carried out.

The main generation source of the country is the hydro system that produces about the 80% the electricity. Others no contaminating sources as wing and biomass provided during the year 2008 2% of the total electricity produced in Costa Rica.

The direct use of the geothermal energy as swimming pools has been a modest development. Additional direct use is related with a vegetables dehydration plant that will be installed at Miravalles by Instituto Costarricense de Electricidad (ICE) and Ministerio de Agricultura y Ganaderia.

1. GENERATION SYSTEM

Historically, the electricity generation system in the Costa Rican Republic has been based on programs oriented mainly towards the utilization of the country's domestic renewable natural resources. These programs are the result of a plan based upon the utilization of domestic renewable resources, hydro, geothermal, wind and biomass, which has been applied since the second half of the past century. Costa Rica, with a territory of approximately 51,000 km2, is located at the extreme southeast of the Central American isthmus. Due to the particular configuration of its territory, it includes a high mountain belt with high annual precipitation, many young volcanoes and good wind systems. Costa Rica has very favorable conditions for the construction of hydroelectric, geothermal and wind plants. As a matter of fact, hydro resource is the country's main electricity production source. Only during the year 2008, hydroelectric plants, accounted for 62% of the total Costa Rica electrical system, provided 79 % of the total electricity produced by the country and, with small variations in the 2004-2008 quinquenniun, were the main source of electric energy production. During the year 2008, the geothermal plants installed at the Miravalles Geothermal Field (figure 1), whose capacity at that time was equivalent to 7 % of the total installed capacity, generated 12 % 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 2008, the renewable cycle electric plant system (wind and biomass) equivalent to 4% of the available installed capacity provided 2% of the energy produced. Finally, the conventional thermal plants, equivalent to 27% of the installed capacity, which operate mainly as a reserve for the electrical system, provided the remaining 7%.

Figure 1: Location of Costa Rica, Miravalles and Rincón de la Vieja geothermal Fields.

In figures 2 and 3, the distribution of the installed capacity, by source, and energy produced is shown for the year 2008.

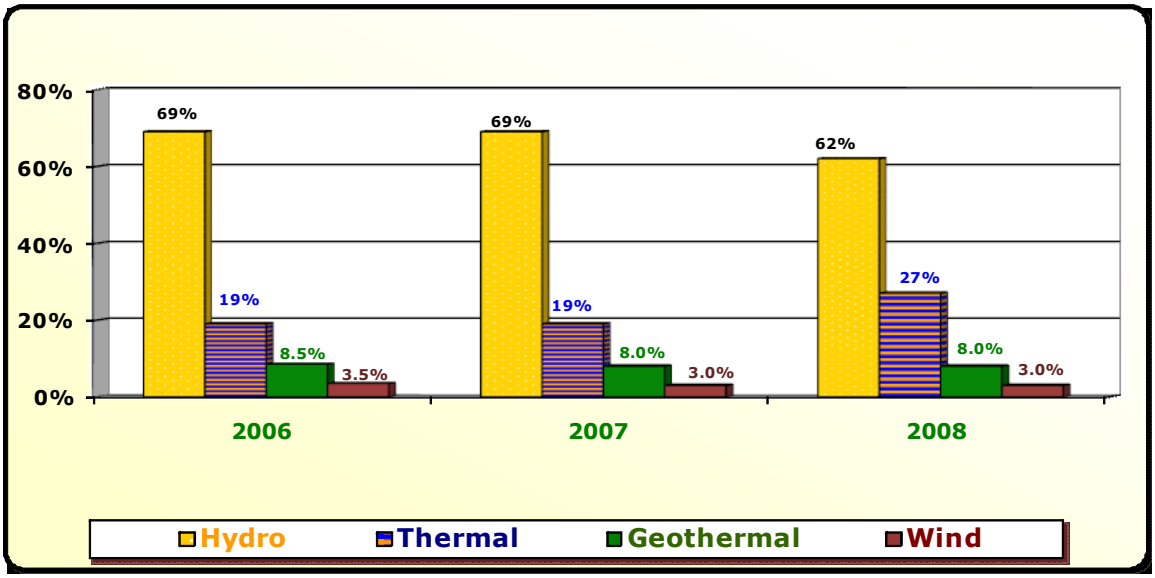

Figure 2: Total installed capacity, by source, at the end of 2008.

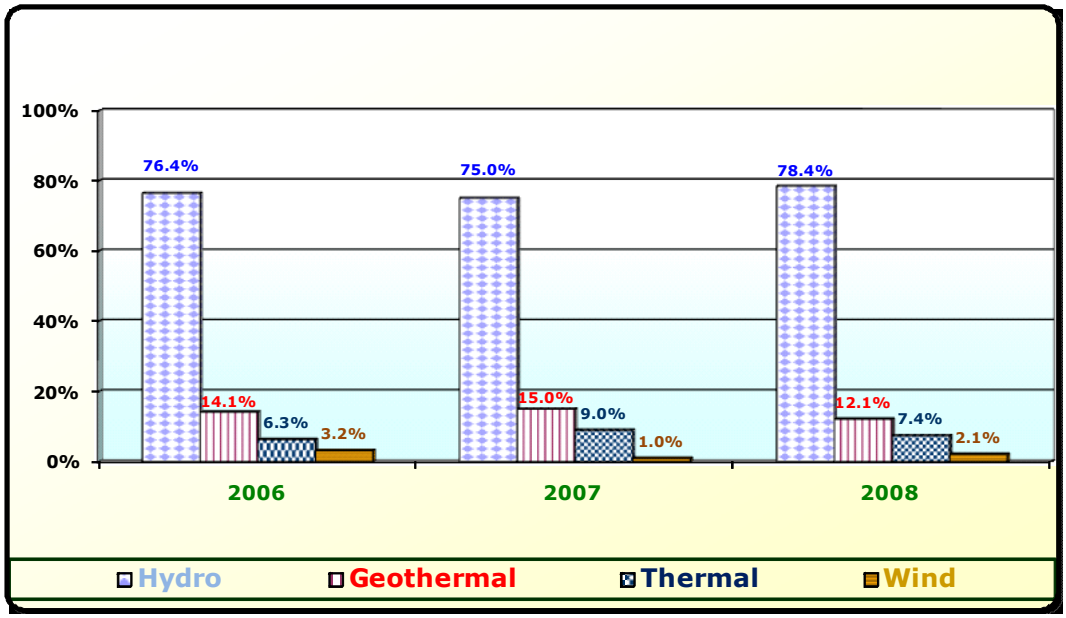

Figure 3: Total electricity generation, by source, in 2008.

2. MIRAVALLES GEOTHERMAL FIELD

With the incorporation at the end of 2003 of Miravalles V, a 21 Mw plant which operates on a binary cycle, the installed capacity in the field reached 165.5 Mw. Based on the mathematic reservoir models and physical-chemical log of the permanently extracted fluids, the acquired information indicates that 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 were 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. And 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, (ICE) the only public entity permitted by law to investigate, to develop and to 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. The injection areas are located in the west and south of the field. Finally to the east there is a high non condensable gas zone. (see figure 4).

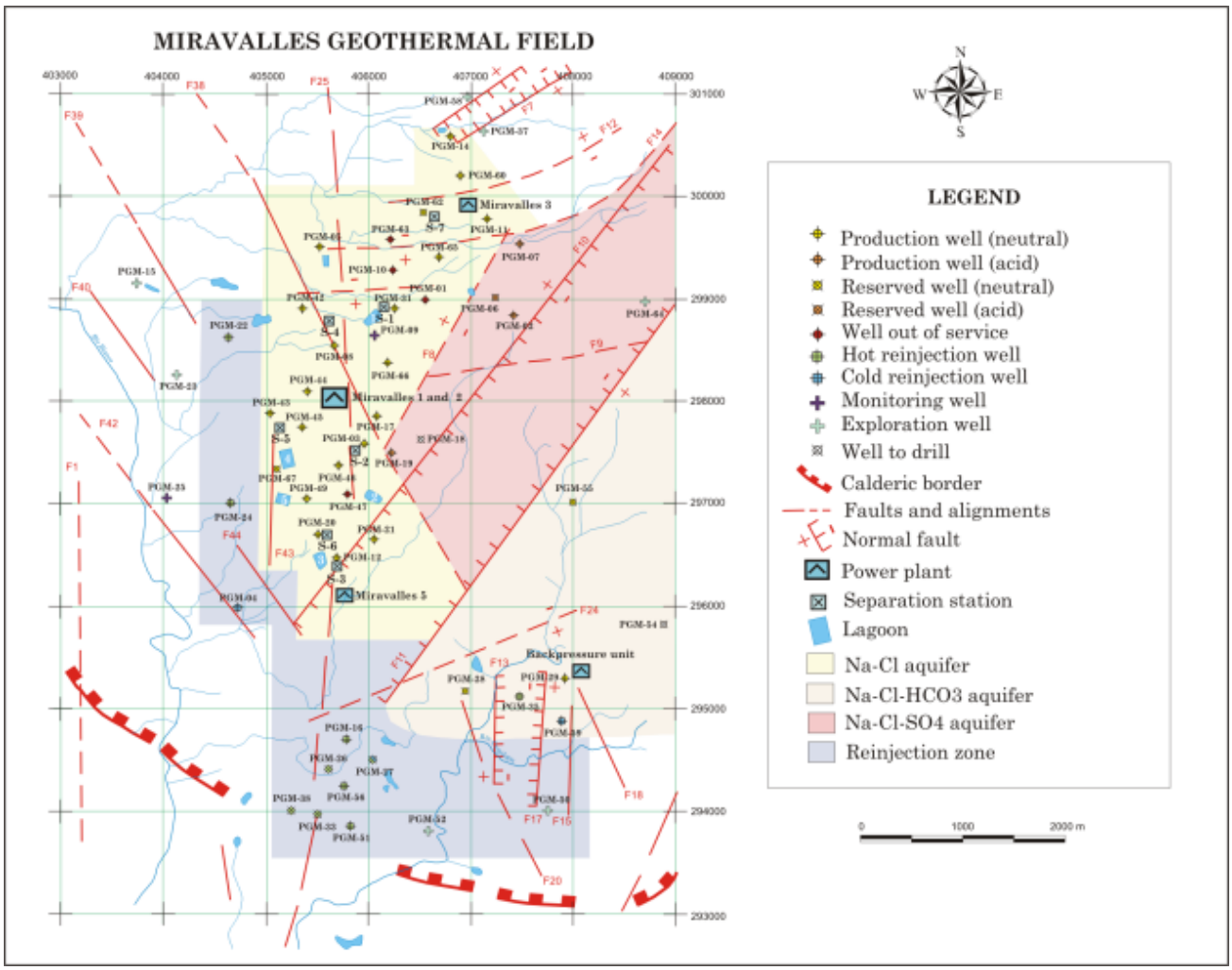

Figure 4: Miravalles Geothermal Field

In all, 53 deep wells have been drilled, of which 33 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, actually some wells are used for controlling reservoir evolution. Of the 33 production wells, 29 produce fluids from the main, neutral pH, reservoir whereas four produce fluids from the secondary, low pH, reservoir. To date, the physical-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.

Figure 5: Miravalles I and II seen from Miravalles slope

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. RINCON DE LA VIEJA GEOTHERMAL AREA, LAS PAILAS AND BORINQUEN FIELDS

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 they are still in the 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.

3.1 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 2011, began. The area covered during the feasibility study corresponds to a narrow zone located between the Blanco and Colorado rivers. (See fig. 6) 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. One binary plant (41 Mw gross, 35 Mw net) is under construction and will be on line in the second half of 2011.

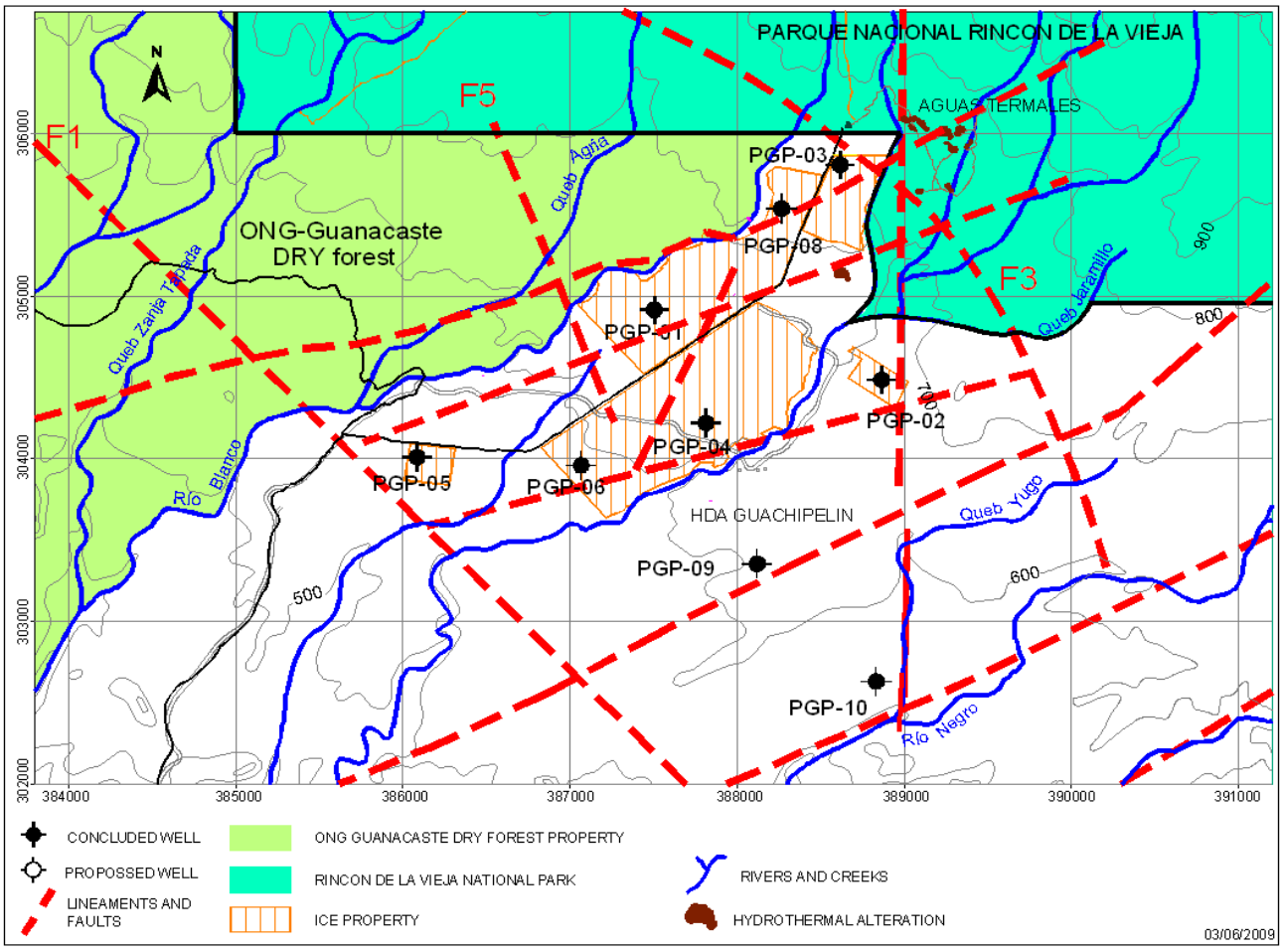

Figure 6: Las Pailas Geothermal Field

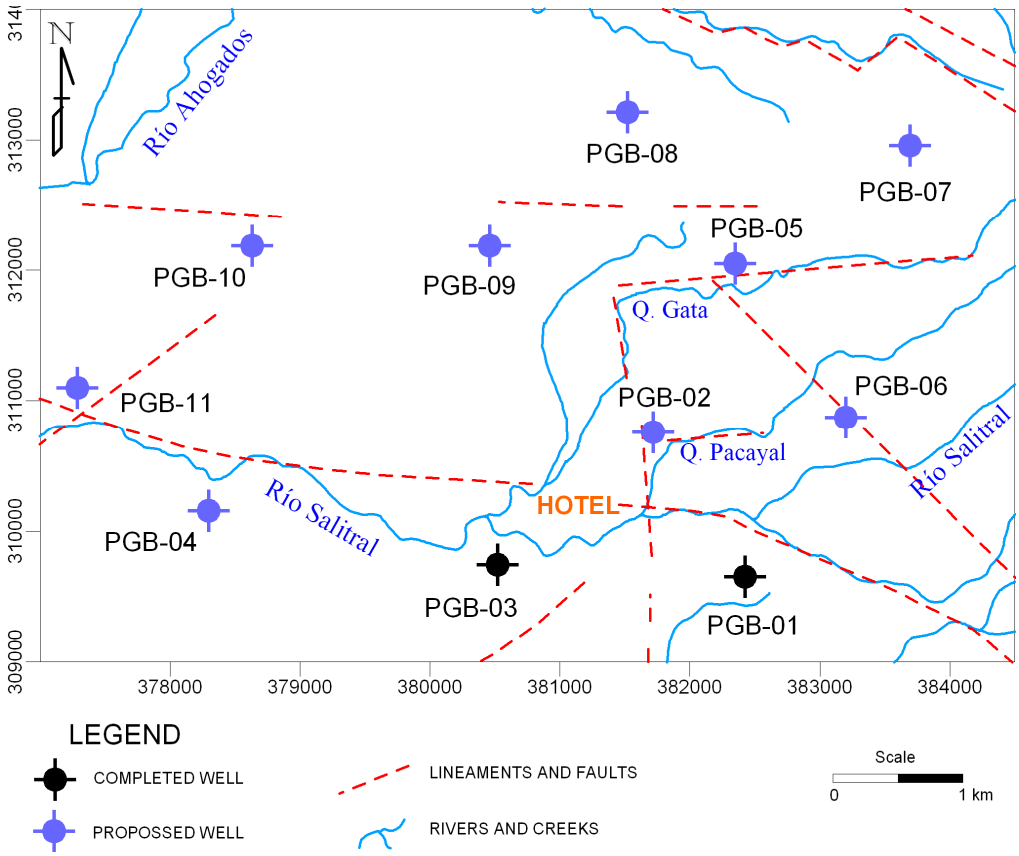

Figure 7: Borinquen Geothermal Project.

3.2 Borinquen Geothermal Project

Once the wells for the feasibility study in Las Pailas had been drilled, the drilling exploration well was begun at the Borinquen project (see fig. 7), located at the north-western extreme of the area under exploration at the Rincón de la Vieja volcanic complex. 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.

4. 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 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, must be take into consideration local factors where, due the geographic location of Costa Rica, between 9 and 11 degrees north latitude, there are 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.

Finally with the attendance of the Ministerio de Agricultura y Ganadería the Instituto Costarricense de Electricidad (ICE) completed the technical study for the installation of a plant pilot for the drying of vegetables and grains (onion, rice, beans ets.) that will settle in the Southern sector of the geothermal field. The system for vegetable drying, will operate making use of a fraction of the heat available in the geothermal waters that are disposed.

REFERENCES

Instituto Costarricense de Electricidad, El Sector Eléctrico Nacional, 2008

Table 1: Present and planned production of electricity (December 2008)

	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 Prod. GWh/yr	Capacity Mwe	Gross Prod. GWh/yr
In operation in December 2008	165.5	1131	422	699	1500	7383	0	0	94	199	2182	9412
Under construction in December 2009	41	291	200	N.A.	202		0	0	50	156	487	N.A.
Funds committed, but not yet under construction in December 2009	N.A.		N.A.		N.A.		N.A.		N.A.		N.A.	
Total projected use by 2015	206.5	1422	622		2002				344		2669	9412

Others renewables: 179 GWh/yr wind, 20 GWh/yr biomass

Table 2: Present and planned production of electricity – In December 2008

Locality	Power Plant Name	Year Comissioned	No. of Units	Status (1)	Type of Unit (2)	Total Installed Capacity Mwe*	Total Running Capacity Mwe*	Annual Energy Produced 2009 3) GWh/yr	Total under Const. or Planned Mwe
Miravalles	Miravalles I	1994	1		F	55	55	433	
	Miravalles II	1998	1		F	55	55	327	
	Miravalles III	2000	1		F	29.5	29.5	220	
	Miravalles V	2003	2		B	21	21	108	
	Back Pressure	1994	1		F	5	5	43	
Pailas	Pailas I	2011	2		B				41
Total			8			165.5	165.5	1131	41