



Negocio Ingeniería y Construcción  
Departamento de Recursos Geotérmicos

# Geothermal Development Lessons learned in Costa Rica 2017



Geol. Leonardo Solís S

Source: bespokeyachtcharter.com



Source: semanariouniversidad.com

# Historic Context

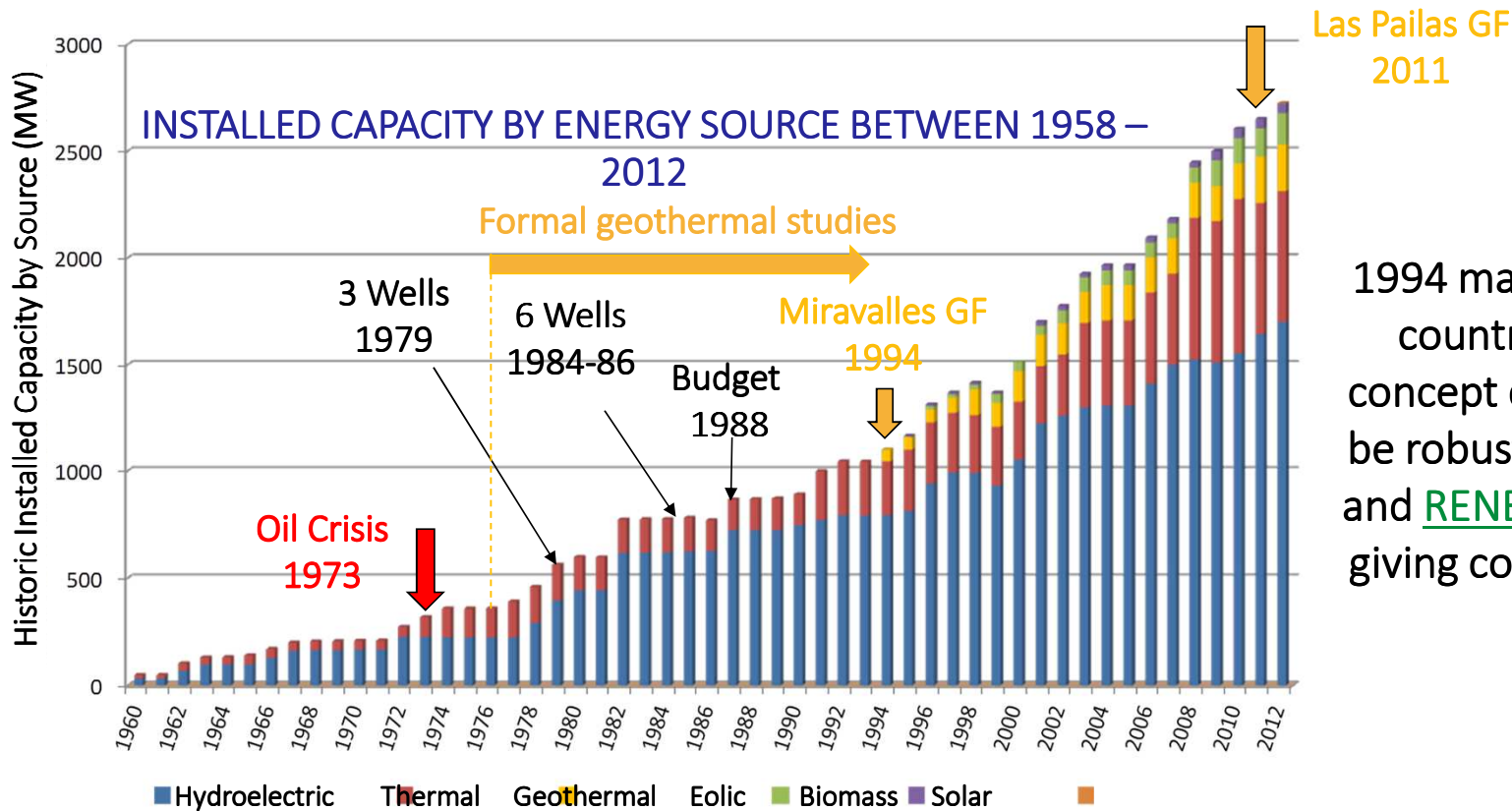
Instituto Costarricense de Electricidad  
(ICE) legal framework (1949) Law n° 449

- *-" The Costa Rican Electricity Institute is created, hereinafter called The Institute, which is entrusted with the rational development of physical energy production sources that the Nation has, especially water resources. The fundamental responsibility of the Institute to citizens will be to channel the use of hydroelectric energy in order to strengthen the national economy, and promote the greater well-being of the people of Costa Rica....."*

Geothermal in Costa Rica legal framework  
(1976) Law n° 5961

- *-" It is declared of public interest the investigation, exploration and exploitation of geothermal resources of the country, and all the activities related will be carried out by the Instituto Costarricense de Electricidad (ICE)...."*
- *-"... Geothermal resources are defined as the energy accumulated in subsurface waters that, due to different geological processes, are found at high temperatures and pressures."*

# COSTA RICA HISTORICAL GEOTHERMAL DEVELOPMENT



1994 marks a Milestone for the country, the energy matrix concept changes: must not only be robust, but based on reliable and **RENEWABLE** energy sources giving confidence to the System

## Costa Rica Achieves Two New Records in Sustainability Effort

PR Newswire

© Jul. 26, 2017, 08:30 AM

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SAN JOSE, Costa Rica, July 26, 2017 /PRNewswire/ -- In just the first half of 2017, Costa Rica has reached a new record in clean energy production and received their latest Biosphere Reserve declaration by UNESCO (United Nations Educational, Scientific and Cultural Organization)—solidifying their unshakeable commitment to sustainability.



During the first six months of the year, 99 percent of Costa Rica's electricity came from renewable sources, according to data from the

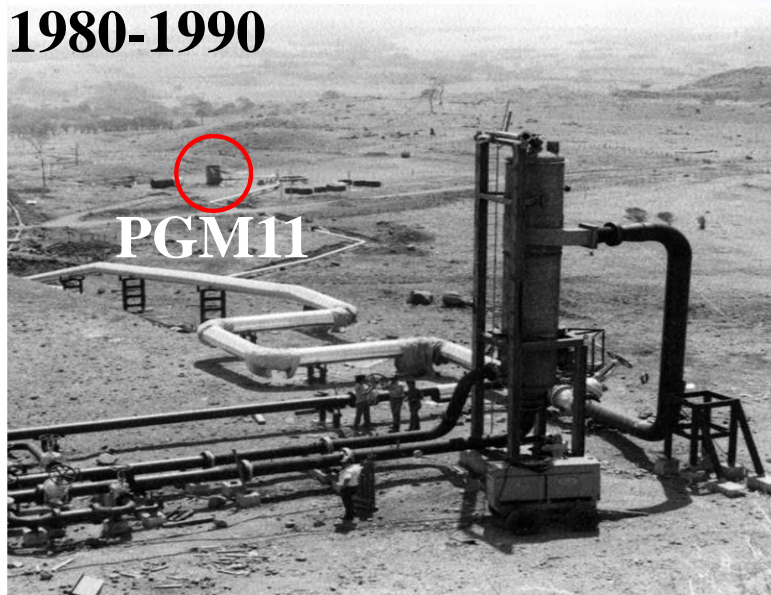
SAN JOSE, Costa Rica, July 26, 2017 /PRNewswire/ -- In just the first half of 2017, Costa Rica has reached a new record in clean energy production and received their latest Biosphere Reserve declaration by UNESCO (United Nations Educational, Scientific and Cultural Organization)—solidifying their unshakeable commitment to sustainability.

During the first six months of the year, 99 percent of Costa Rica's electricity came from renewable sources, according to data from the National Energy Control Center (CENCE). In the last 30 years, renewable sources such as wind, **geothermal**, solar and hydroelectric have been responsible for production of nearly 93 percent of Costa Rica's energy, but this July they broke their own record. With a goal to be the first carbon neutral country in the world by 2021, sustainable practices can be observed in every region of the country, across all industries, adopted by all citizens and embraced by visitors. With almost all of its energy being produced by renewable resources, it's clear that sustainability is embedded deeply in the culture and traditions of Costa Rica.

Geothermal development, an important part for Costa Rica  
sucessfull history!!!

Miravalles in the  
beginnings...  
back in the 80's

1980-1990



Guayabo town: a town dedicated to cut down trees, cattle, agriculture and hunting. Vertical drilling technology, with 1 well per pad, 52 hectares of pads. Several kilometers of internal roads and pipelines. Reforestation began as part of the ICE model used for hydroelectric developments basin manage.

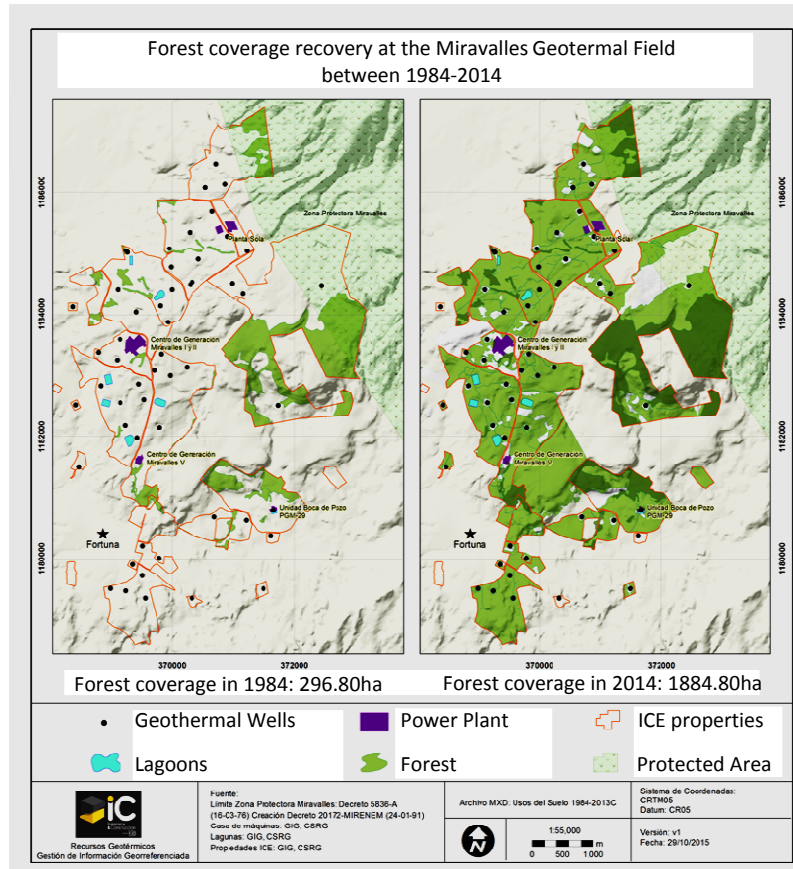
Based on the experience of Miravalles Geothermal Project and after 23 years of operation, the area of the Project changed its landscape **dominated by grassland dedicated to cattle** to one **dominated by secondary forest through regeneration and exclusion** of other activities like cattle, cut down of trees and human caused brush fires.

2013

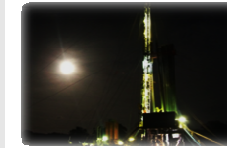
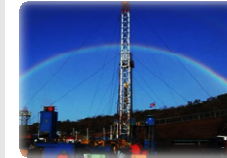


# Recovery of Forest Area Miravalles Geothermal Field

**1984**  
**296.80ha**



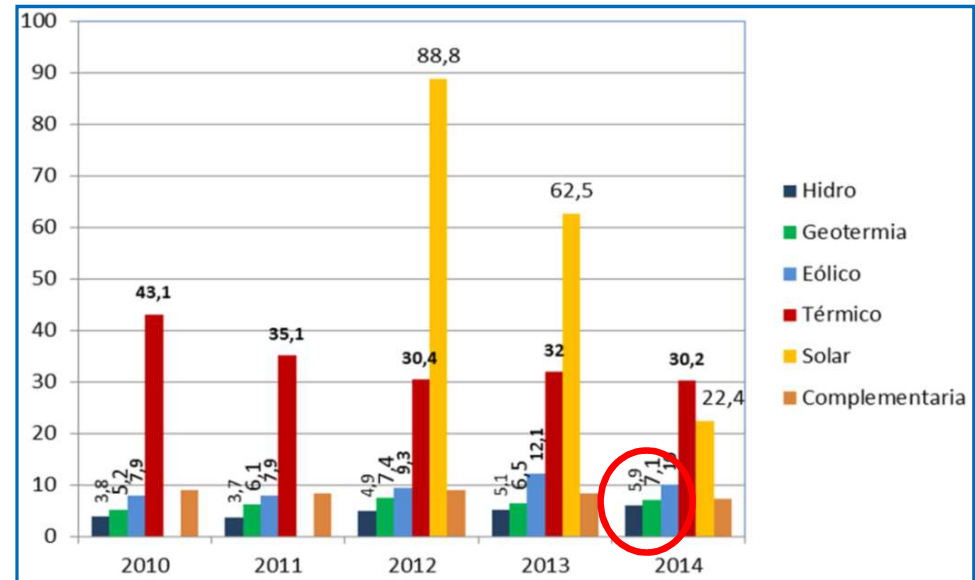
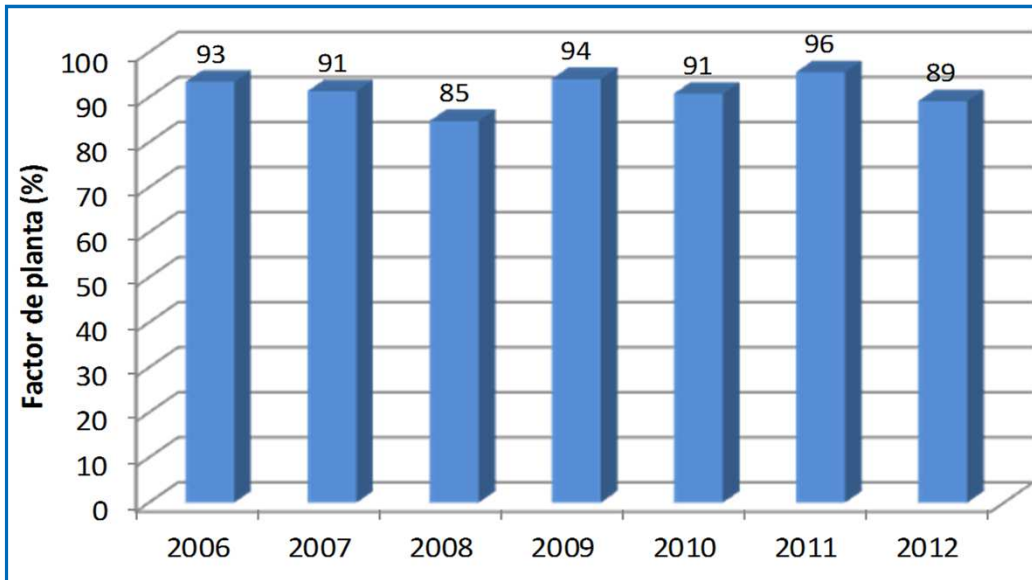
**2014**  
**1884.80ha**





## Profitable

- Despite initial inversion is high at the beginning, the geothermal energy plant factor is high enough to sustain a competitive -profitable development.



## Normal evolution of NCG in Miravalles

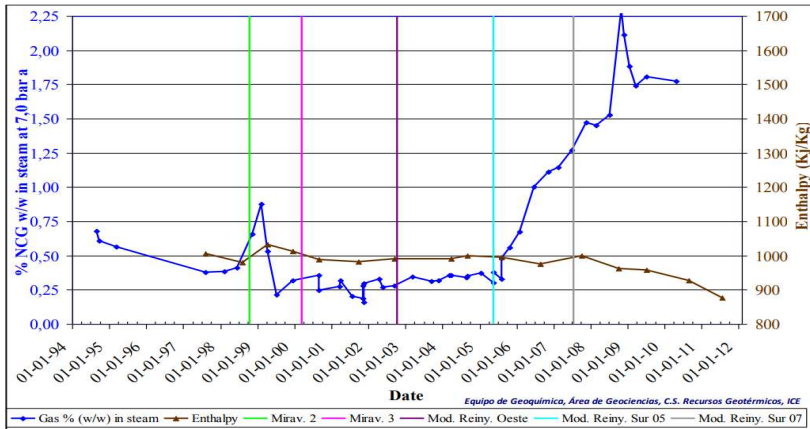


FIGURE 14: PGM-49. Relation of NCG vs. enthalpy. Peripheral aquifers invasion.

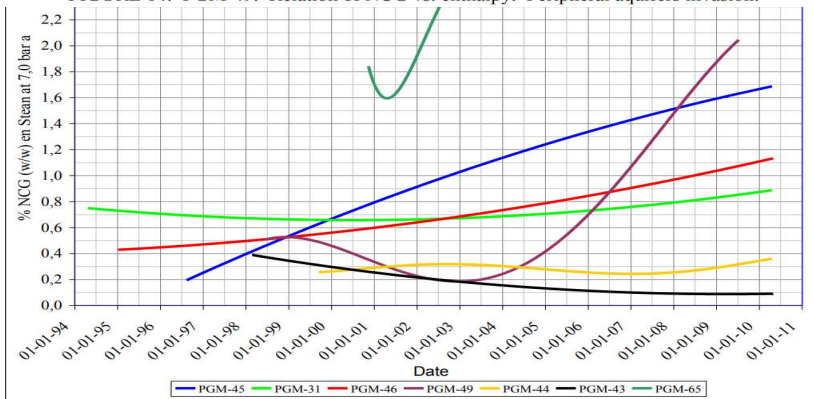


FIGURE 12: Miravalles wells NGC content variation in the steam, at 7,0 bar abs

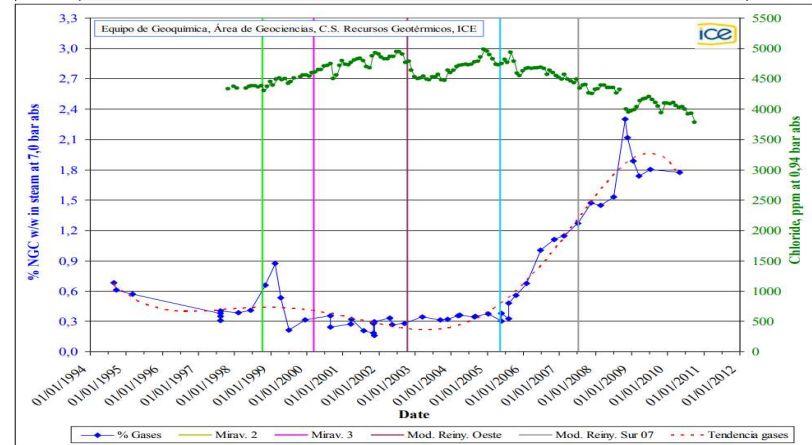
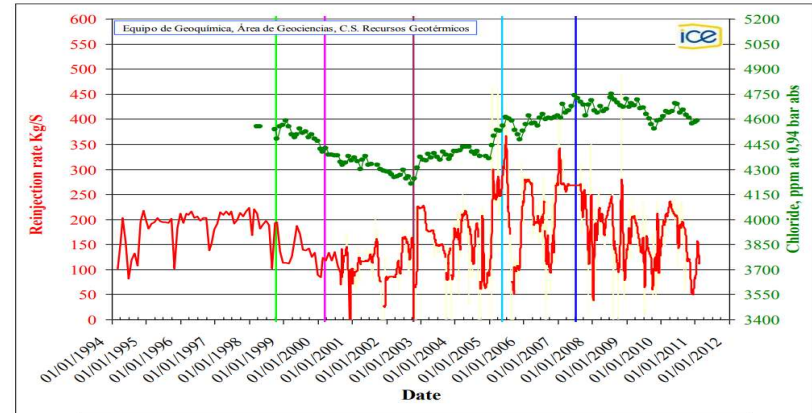
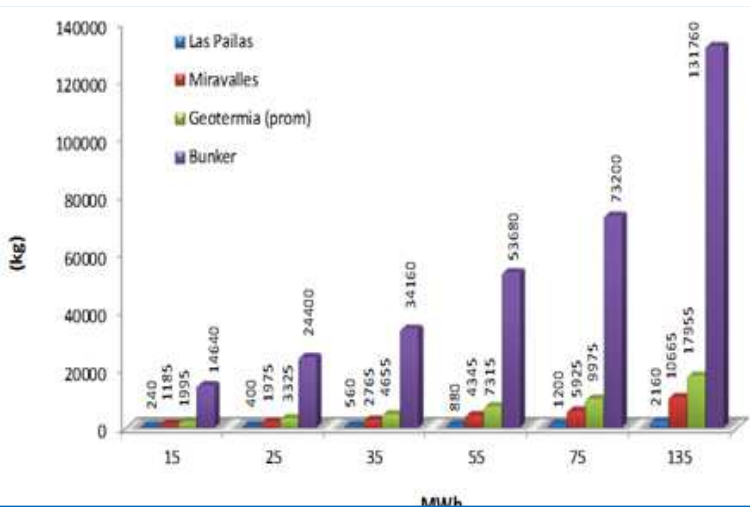


FIGURE 16: PGM-49. Invasion of peripheral waters

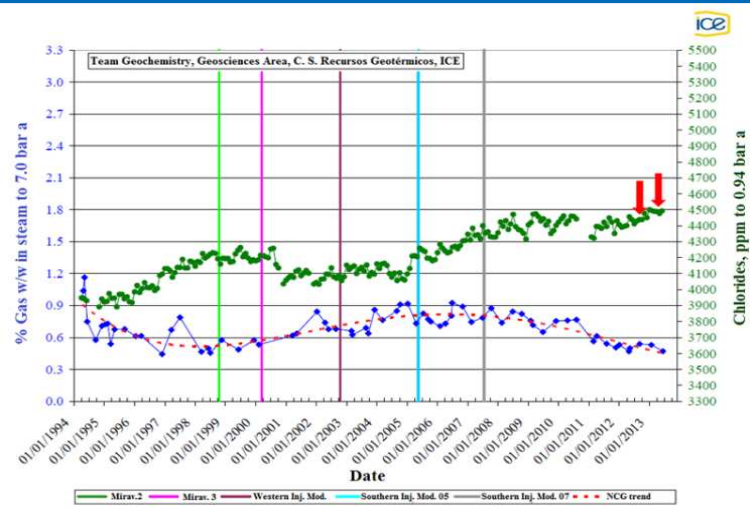


## Adequate manage of NCG emissions

- Compared to traditional fossil combustion production, geothermal is a very clean energy source.
- The longer exploitation of the geothermal reservoirs increase NCG in production mass. But with an adequate operational management plan of production-reinjection rates monitored by geochemical sampling, this emissions can be managed.
- Reforestation of the surroundings areas, allows young trees to consume CO2 as they grow, giving an excellent balance between emissions and capture.
- This adequate manage of NCG emissions, is a decisive impulse of Costa Rica to become neutral carbon country



Private owner's land (2001)



Land acquired by ICE, after few years (2012).



# Social- economical Impact



**Improvement of living conditions**

**Job Opportunities (447 workers direct from Geothermal developments)**



# Pailas I, the transition for Costa Rican Geothermal Development Model

Diciembre 2007



ICELAND - UNU/GTP - LaGeo

El Salvador, 2007



Enero 2008



Julio 2008



Agosto 2009



Stakeholders meetings and workshops  
Getting to know each other....



# Framework Agreement for the Geothermal **Bio-development** in Mundo Nuevo area



2 junio 2007



CONVENIO MARCO DE COOPERACION ENTRE EL ICE Y EL MINAE/ACG  
PARA EL BIODESARROLLO GEOTERMICO MUNDO NUEVO  
CON-087-07

## CARTA DE ENTENDIMIENTO PARA ESTUDIOS DE PREFACTIBILIDAD PARA EL DESARROLLO GEOTERMICO MUNDO NUEVO

Entre Nosotros, Salvador López Alfaro, mayor, casado, Ingeniero Eléctrico, vecino de San José, portador de la cédula de identidad número uno-cuatrocientos diecinueve-cuatrocientos quince, actuando como delegado de la Presidencia Ejecutiva del Instituto Costarricense de Electricidad y Alejandro Masis Cuevillas, mayor, casado, Biólogo, vecino de Liberia, portador de la cédula de identidad número uno-cero ochocientos diez y seis- cero ciento cuarenta y uno, en mi calidad de Subdirector del Área de conservación Guanacaste y CON BASE EN EL CONVENIO MARCO DE COOPERACION ENTRE EL ICE Y EL MINAE/ACG PARA EL BIODESARROLLO GEOTERMICO MUNDO NUEVO

ACORDAMOS SUSCRIBIR LA PRESENTE CARTA DE ENTENDIMIENTO, que se registrá por las siguientes Cláusulas:

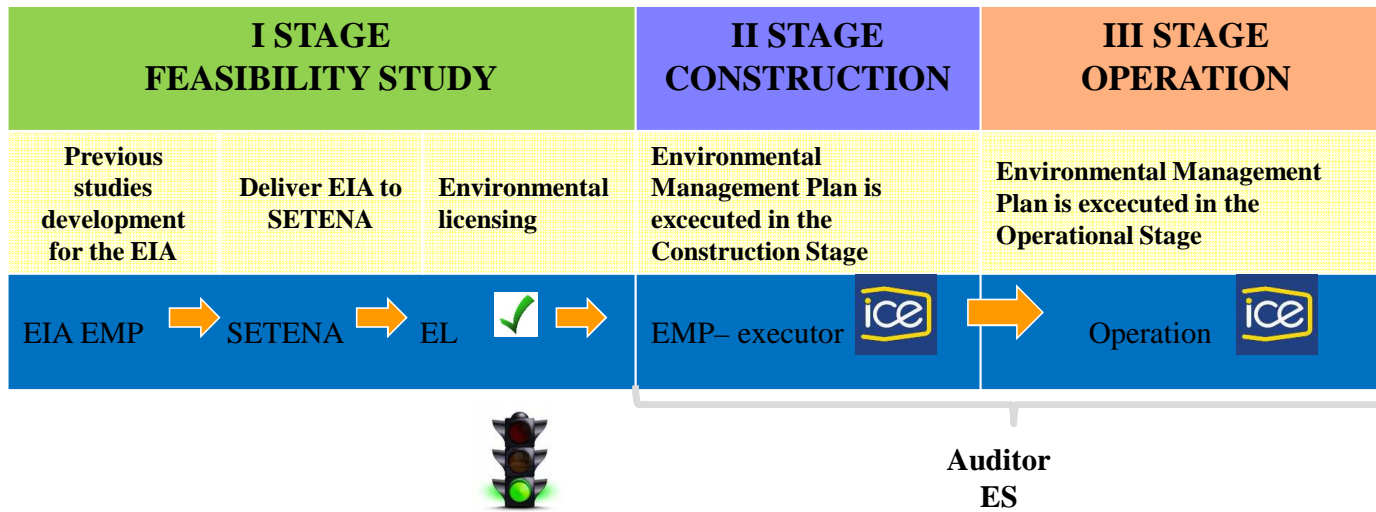
### CLAUSULA PRIMERA. OBJETIVO:

La presente Carta de Entendimiento tiene como objetivo definir los parámetros para ejecutar las actividades ambientales que sean necesarias en la fase de prefactibilidad del Proyecto de Biodesarrollo Geotérmico Sector Mundo Nuevo, de manera que las actividades se lleven a cabo con el menor impacto posible en la biodiversidad y ecosistemas acuáticos y terrestres del Sector Mundo Nuevo.

# Environmental management framework

## Environmental organic law N°7554 (1995)

### STAGES OF A PROJECT AND ITS LINKAGE TO SOCIAL AND ENVIRONMENTAL MANAGEMENT



**EIA:** Environmental Impact Assessment

**EMP:** Environmental Management Plan

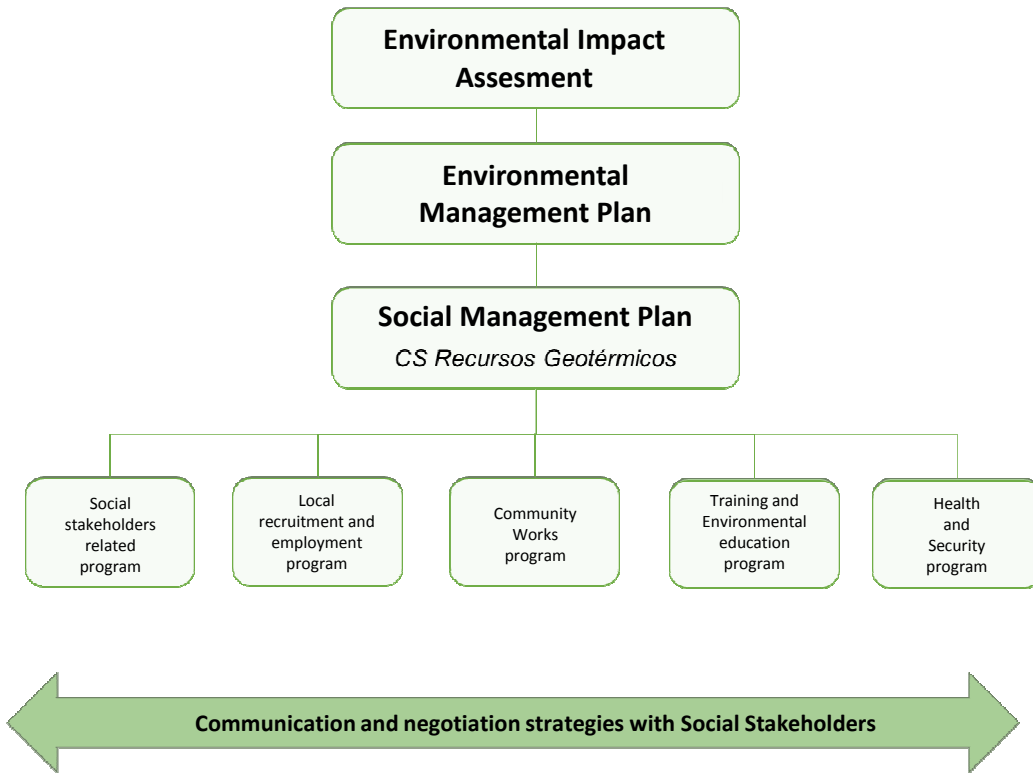
**EL:** Environmental licensing

**ES:** Environmental Specialist





# SOCIAL MANAGEMENT PLAN STRUCTURE



## Mechanisms and Proceedings for Social Management

- Employment priority for locals
- Reception and attendance of unforeseen impacts, consultations, requests, complaints, nonconformities.
- Procedure for management of community works.

## Old and erroneous concepts

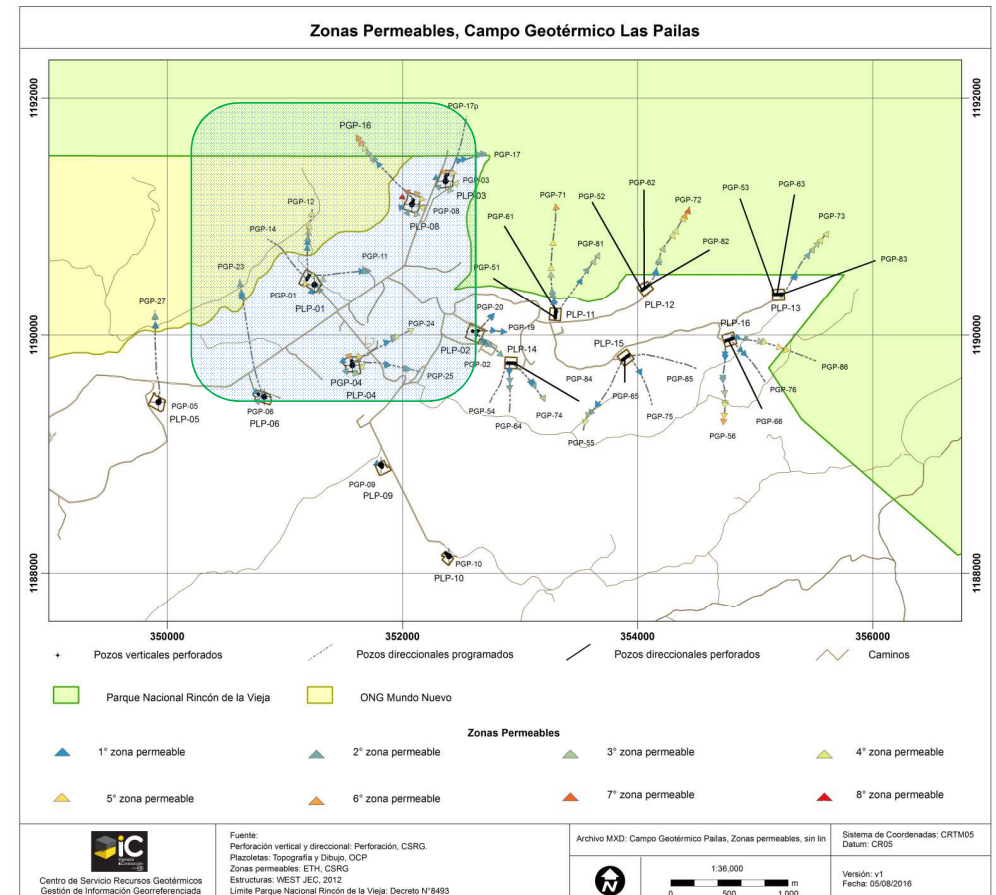


# Environmental responsibility and order



# Campo Geotérmico Pailas I

- Star-up operations in 2011
- 42,5 MW installed
- Total pipeline length: 13.86 km (including sewerage system)
- Pressure pipeline: 7.77 km
- 20 wells



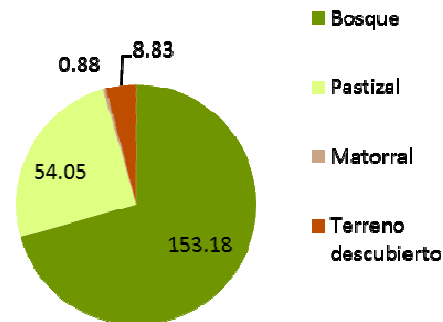
# Recovery of Forest Area Las Pailas I Geothermal Field (7 years)



**1998**

**153.1ha Forest**  
**0.88ha bushes**

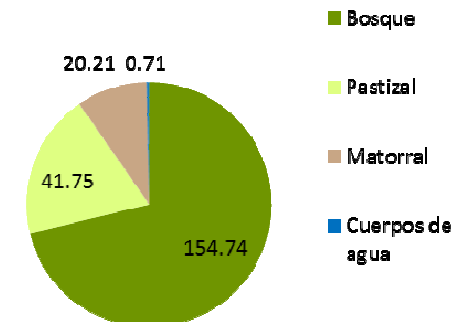
Distribución de áreas



**2005**

**154.7ha Forest**  
**20.21ha bushes**  
**0.71 water bodies**

Distribución de áreas





**Dry Season  
2001**



**Rainy season  
2001**

**Recovery of areas  
LAS PAILAS  
Geothermal Field**

**Platform  
PGP-2-19-20**



**2012**



# Pailas II and Borinquen... XXI Century Geothermal Model for Costa Rica



CONSULTORES BID 2012



ICE-ACG/GDFCF-JICA 2014



ICE-ACG-GDFCF-JICA-ERM 2015

**Stakeholders meetings  
Working together....**







17:05-17:25

**4. Practical environmental considerations for geothermal development as a clean energy source adjacent to Area de Conservacion Guanacaste (ACG), a Natural Heritage Site, in northwestern Costa Rica: Joint experiences**  
Mr. Sergio Bermúdez Muñoz, Planning and Electric Development, Instituto Costarricense de Electricidad (ICE)  
Mr. Roger Blanco, Coordinator of Research, ACG, Costa Rica

ROGER BLANCO (rblanco@acguanacaste.ac.cr)



Japan International Cooperation Agency

Lima, Perú  
16 Marzo, 2016



## PROYECTO GEOTERMICO LAS PAILAS II

### ENVIRONMENTAL VARIABLE INCORPORATED FROM THE VERY BEGINNING OF THE PROJECT CONCEPTION

- LESS DRILLING PADS AND RELOCATED ACCORDING TO ENVIRONMENTAL SUGGESTIONS
- ROADS REDUCTION IN QUANTITY AND SIZE
- CHANGES IN PIPELINES AND ROADS ROUTES ACCORDING TO ARCHEOLOGICAL DISCOVERIES
- MAINTENANCE OPERATIONAL ACTIVITIES WITH SPECIFIC SCHEDULE TO REDUCE NOISE AND FAUNA IMPACT



## PROYECTO GEOTERMICO LAS PAILAS II

ENVIRONMENTAL VARIABLE INCORPORATED FROM THE VERY BEGINNING OF THE PROJECT CONCEPTION

- Traditional lights changed for more efficient dimmable led, with less attractive for insects wavelength. In drilling towers and Power Plant

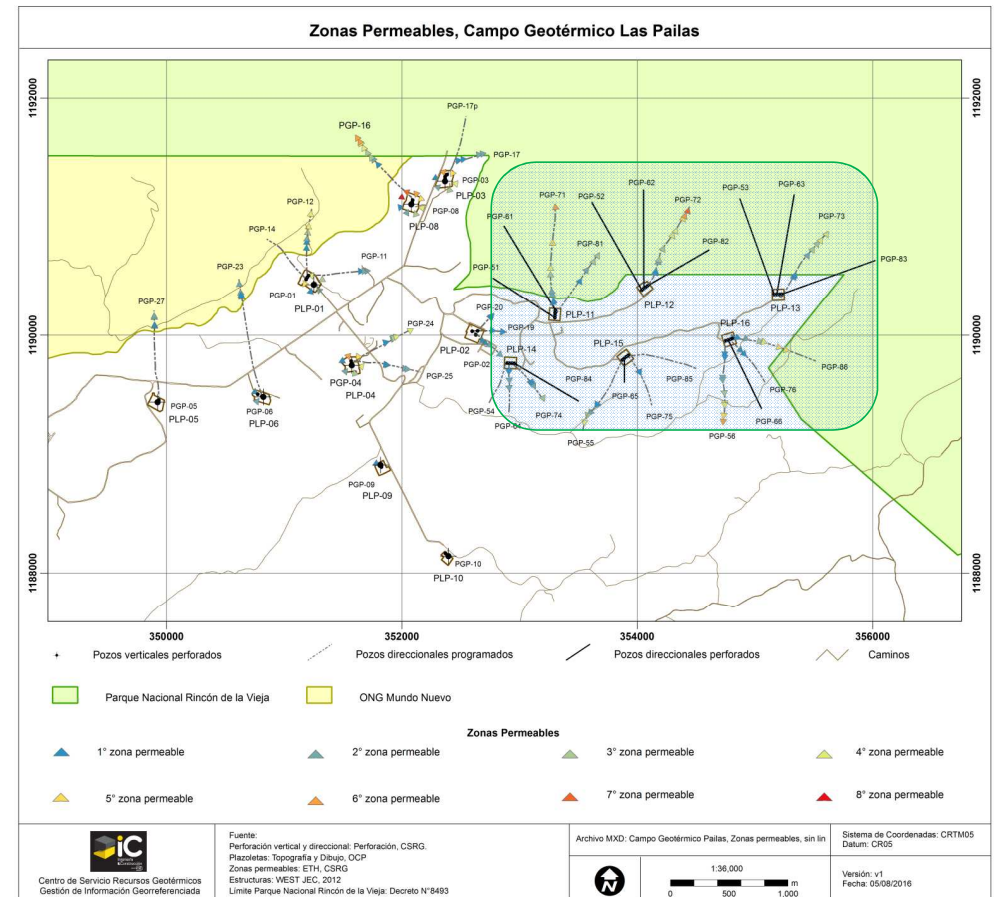






# Campo Geotérmico Pailas II

- Start-up scheduled for January 2019
- Capacidad 55 MW
- Total pipeline length: 13.88 km (including sewerage system)
- Prepressure pipeline: 8.63 km
- 21 Wells to be drilled (6 remaining)





*Duellmanohyla rufiocularis*  
Rana de ojos rojos



*Cebus capucinus*  
Mono capuchino



*Tamandua mexicana*  
Oso hormiguero



*Puma concolor*  
Puma o León de montaña



*Panthera onca*  
Jaguar



*Odocoileus virginianus*  
Odocoileo cola blanca

Positive results captured with trap cameras in the surroundings areas while rigs are drilling





## Area de Conservación Guanacaste

### "JOINT EXPERIENCES BETWEEN ACG AND ICE IN THE RINCON DE LA VIEJA VOLCANO GEOTHERMAL DEVELOPMENT "



ROGER BLANCO (rblanco@acguanacaste.ac.cr)

noviembre, 2016





# Borinquen Geothermal Field Development Design

New conceptual development under multiple and integrated variables:

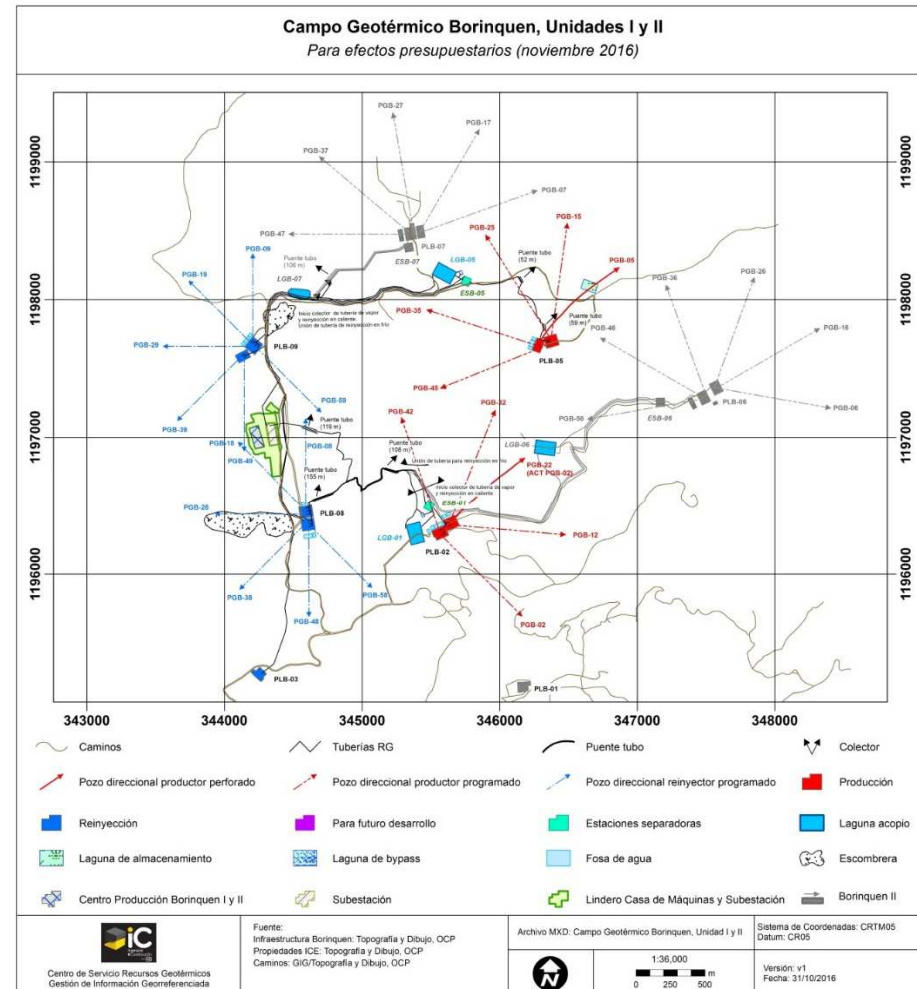
- Geographical, social, archeological and environmental information analysis integrated through SIG, and interpretation focused under current local conditions.
- New flexible operational elements and modular growth.
- Long term exploitation criteria (reservoir and surface facilities).
- Scale economy.

**Borinquen I**  
**55 MW**

Start-up scheduled for  
January 2023

**Borinquen II**  
**55 MW**

Start-up scheduled for 2029 -  
2030



# Nowdays political context

# Proyecto libertario para explotar energía geotérmica en Parques Nacionales fue desechado

© Noviembre 1, 2016 Luis Manuel Madrigal Costa Rica



En primer plano, la Solar Miravalles, en segundo la Geotérmica Miravalles y al fondo, la Eólica Miravalles.

**NACIONAL**

Comisión de Asuntos Agropecuarios dictaminó proyecto

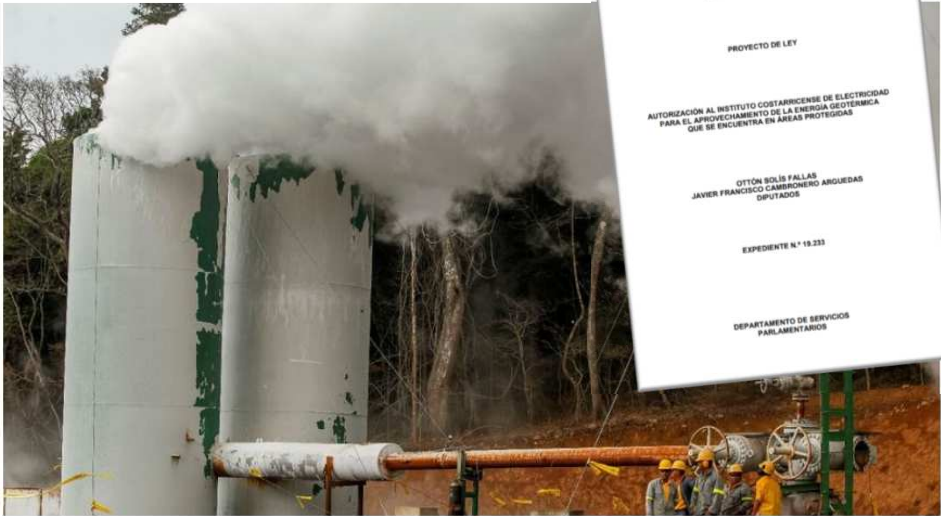
# Plan para explotar geotermia en parques nacionales logró llegar a discusión de plenario

ACTUALIZADO EL 01 DE JUNIO DE 2017 A LAS 11:32 AM

Iniciativa solo autorizaría al ICE para realizar actividad a cambio de pago de canon



POR JUAN FERNANDO LARA S. jlara@nacion.com



En el 2015, el ICE ejecutó \$56 millones en el proyecto de construcción de la planta geotérmica Pailas II, en las faldas del volcán Rincón de la Vieja, en Guanacaste. La planta requiere una inversión de \$164 millones y la financia la Agencia de Cooperación Japonesa (JICA). (GÓRGE ARCE)

Different political groups have shown interest in geothermal development

THE PROJECT THAT REMAINS IN THE ASAMBLEA LEGISLATIVA IS THE ONE THAN ESTABLISH ICE AS THE ONLY ONE IN CHARGE OF GEOTHERMAL DEVELOPMENT



UNIVERSIDAD DE COSTA RICA

CONTÁCTENOS BÚSQUEDA MAPA DEL SITIO CRÉDITOS

# Consejo Universitario

Buscar en nuestro sitio...

INICIO C.U. GACETAS ACTAS ESTATUTO ORGÁNICO NORMATIVA POLÍTICAS PROYECTOS DE LEY DISTINCIONES

## Por tercera vez, UCR sugirió rechazar explotación de energía geotérmica en parques nacionales

Alejandra Amador Salazar  
Periodista  
Consejo Universitario

21  
2017

Twitter Compartir 0 Correo Imprimir

La Universidad de Costa Rica (UCR) le recomendó a la Asamblea Legislativa que no apruebe el proyecto de ley que autorizaría que el Instituto Costarricense de Electricidad (ICE) aproveche la energía geotérmica del Parque Nacional Rincón de la Vieja, Parque Nacional Guanacaste, Parque Nacional Volcán Tenorio y Parque Nacional Volcán Arenal.

Esta es la tercera vez, en los últimos cuatro años, que esta casa de estudios superiores ha sido consultada con respecto a dicha iniciativa. Sin embargo, pese a las modificaciones que se le han incorporado al texto original, el Consejo Universitario considera que, en lo sustancial, la propuesta mantiene elementos preocupantes, entre ellos, la posibilidad de dar autorizaciones especiales para la explotación de fuentes energéticas dentro de las áreas protegidas, que implican la construcción de infraestructura de grandes proporciones que podrían causar daños.



La Escuela Centroamericana de Geología y la Escuela de Biología colaboraron con el Consejo Universitario para emitir el pronunciamiento institucional con respecto al proyecto de explotación de la energía geotérmica. (Foto: costarica.info.com)

## Preocupaciones

Sectores académicos, no obstante, dudan de la iniciativa. El Consejo Universitario de la UCR, por ejemplo, recomendó en febrero de 2016 a la Comisión de Asuntos Agropecuarios no aprobar el proyecto.

Una de sus preocupaciones es que para la explotación del recurso se requiere perforar pozos verticales o dirigidos y llevados por gravedad, puesto que se trata de una mezcla de vapor y agua, hasta la casa de máquinas.

En su informe, la Universidad de Costa Rica (UCR) advirtió además, que la explotación de recursos geotérmicos destruye el bosque natural y afecta la flora y la fauna.

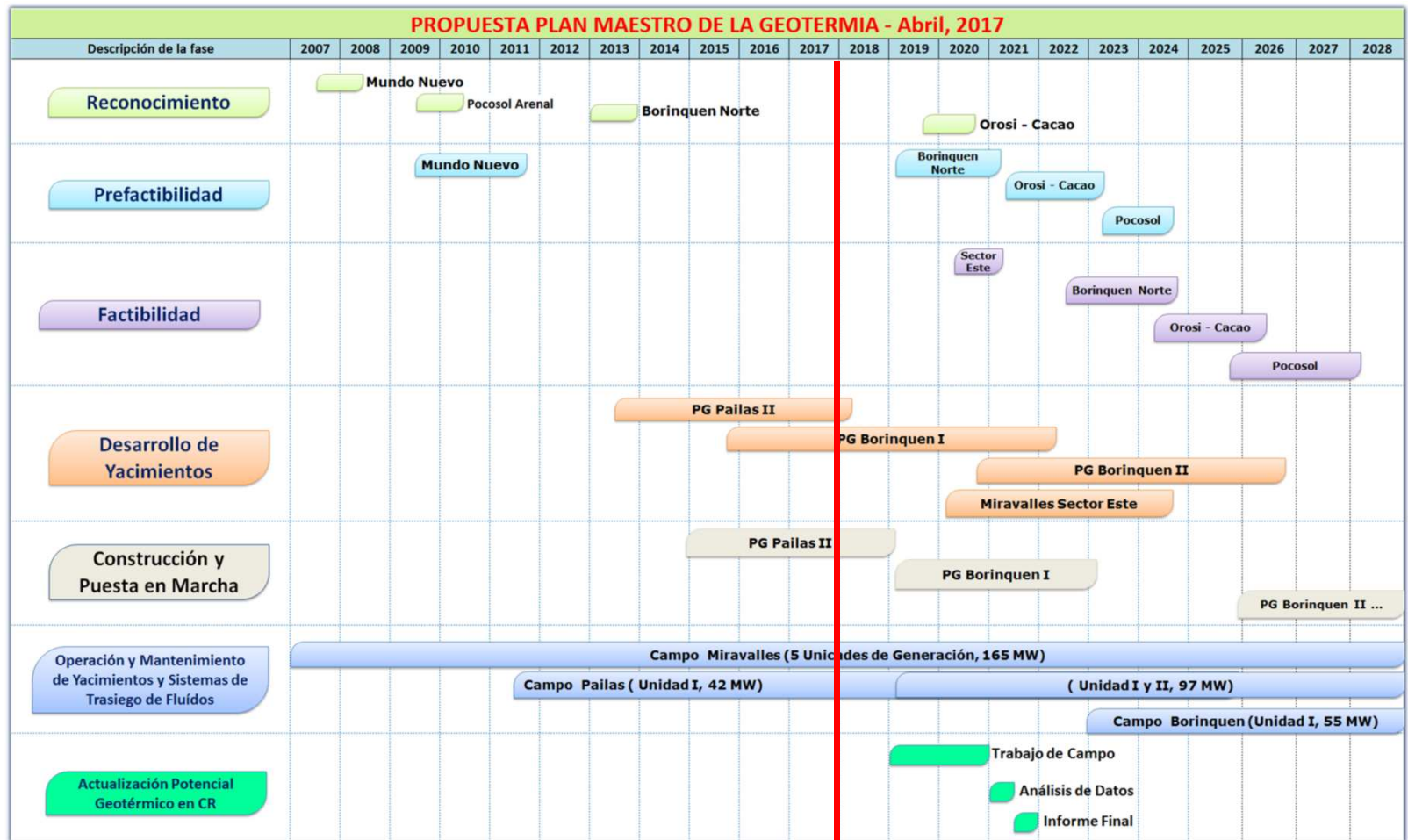
Para ellos, el plan representa "un serio precedente para las áreas protegidas del país ya que fueron creadas con fines de conservación y no de explotación comercial".

Desde el 2014, luego de la presentación de este plan, también el abogado especialista en Derecho Ambiental, Jorge Cabrera Medaglia, advirtió de que Costa Rica ha suscrito tratados internacionales ligados al uso de áreas de conservación, que podrían limitar la aprobación de leyes de esta naturaleza. Es el caso del [Convenio para la Protección de la Fauna, la Flora y las Bellezas Escénicas, de 1940](#).

ICE position: is not about doing it now, in a hurry, is about doing it right, and when all involved are convinced and committed!



# Medium-long term Costa Rica geothermal expansion plan





Since its inception, the Instituto Costarricense de Electricidad (ICE) has promoted and strengthened a model of electricity development based on sustainability, along with the responsible use of natural resources, and therefore, integrating the socio-environmental variable in planning.



## Development with Conservation



# Lessons learned for Costa Rica

- ✓ A proper legal framework is required, but it is not enough to boost geothermal development in a country, it is certainly necessary to involve all stakeholders, listen, work together and incorporate improvements to be successful.
- ✓ Geothermal developments are a great option as long as you have the correct argument to convince the decision makers (it is not the only and last solution, but it's a great complement source of energy for a well developed autochthonous renewable matrix).
- ✓ Start best practices now (Social, Environmental and Technical) even though you are not compelled by any law...time will show the benefits.
- ✓ Design a national medium- to long-term geothermal development plan, to preserve and cultivate a culture of local professionals with the capacity and credibility to convince the decision makers, in order to sustain the geothermal boost over time.
- ✓ Being transparent (Environmental management, Social management, human resources, financial) gives you confidence and support for what you do best...develop great Geothermal Projects.





Picture courtesy of Eng.Diego Mena

**Thank you  
very much!  
Pura vida!**

Aknowledgements

M.Sc. Eddy Sánchez Rivera  
M.Sc Sergio Bermúdez Muñoz  
Ing. Johan Valerio Pérez  
Ing.Elmer González Luna  
Biol.Roberto Fernández Ugalde.