

Geothermal Energy in Costa Rica



A Sustainable Alternative

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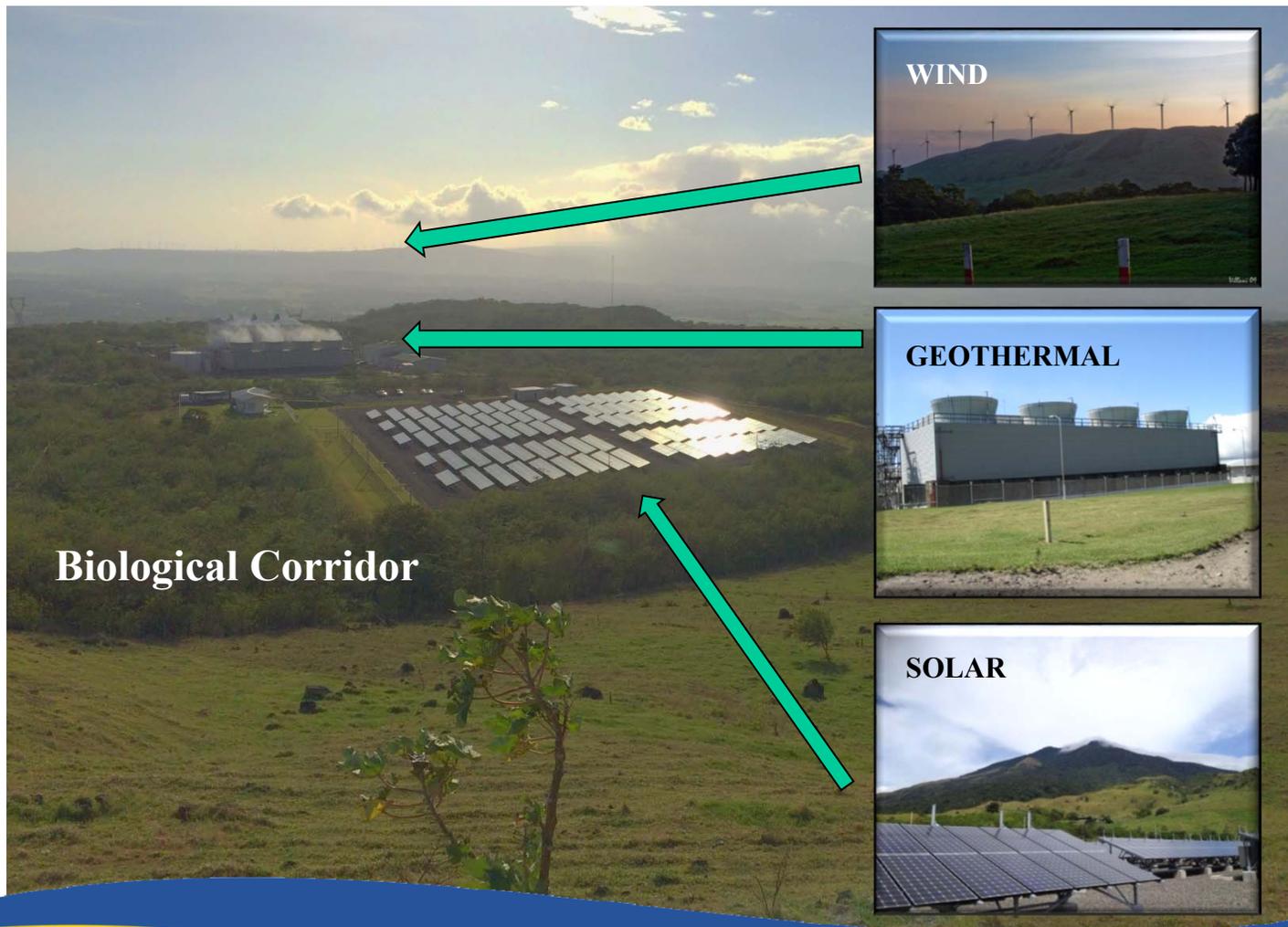
June 2015

Country Policy – Electrical Production

Costa Rica is worldwide recognized as a leader in environmental protection, and has developed and implemented policies in order to protect the country's natural resources. This situation has led the development and exploitation of the energy resources in the country according to these policies.

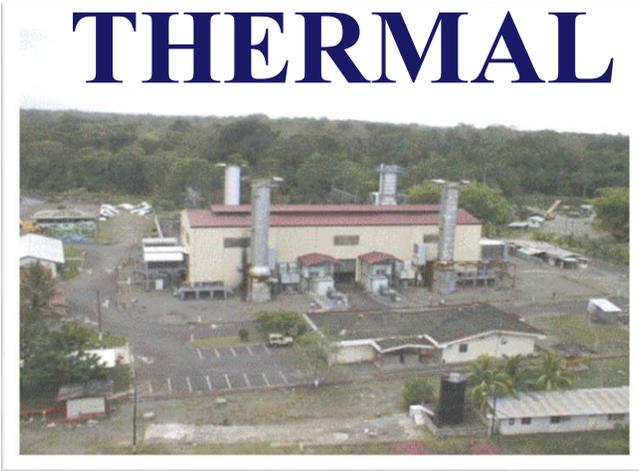
According to the Costa Rica's way of thinking in environmental issues, one of the main goals is to satisfy almost all the electrical generation needs by renewal type sources. At present this goal is fulfilled because in the last years the renewal type sources have generated around or over 90% of the total electrical generation.

Country Policy – Electrical Production



Some Types of Energy and Their Characteristics

THERMAL



NUCLEAR



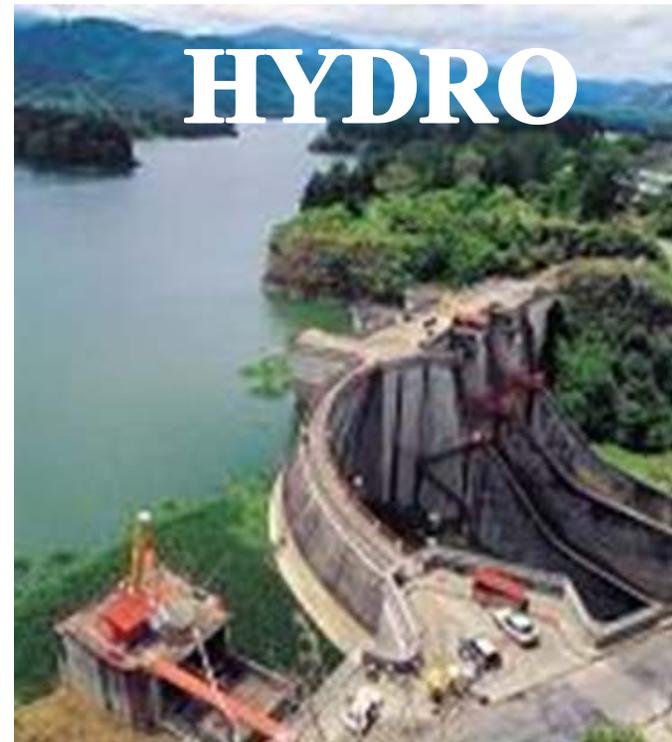
WIND

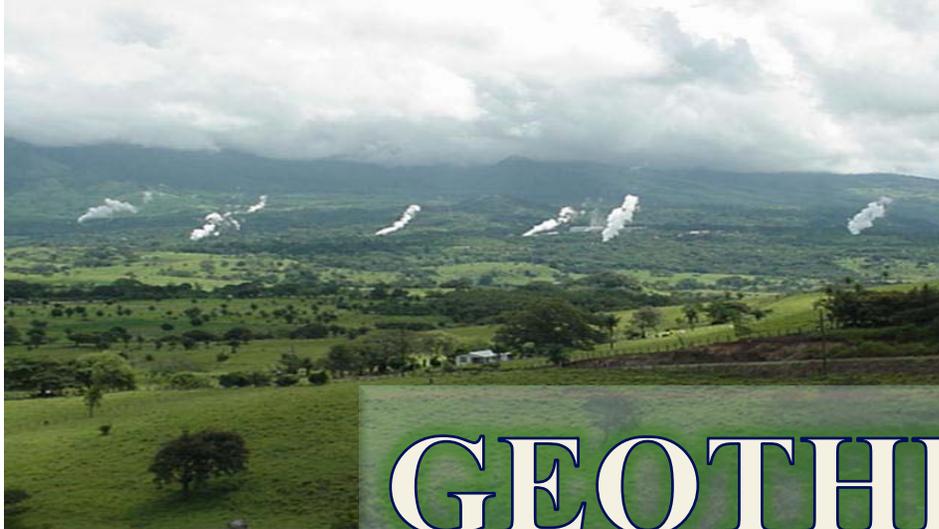


SOLAR



HYDRO



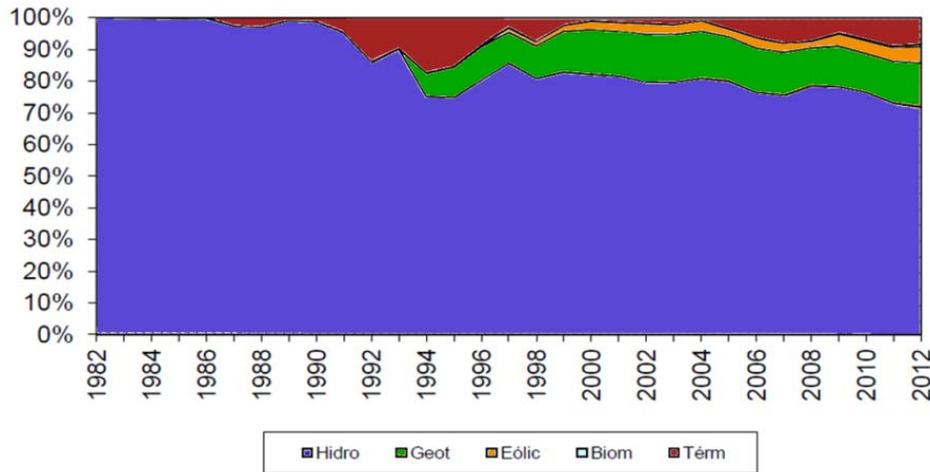


GEO THERMAL



Energy Matrix of Costa Rica

**HISTORICAL GENERATION BY TYPE OF PLANT
PERIOD 1990 - 2012**

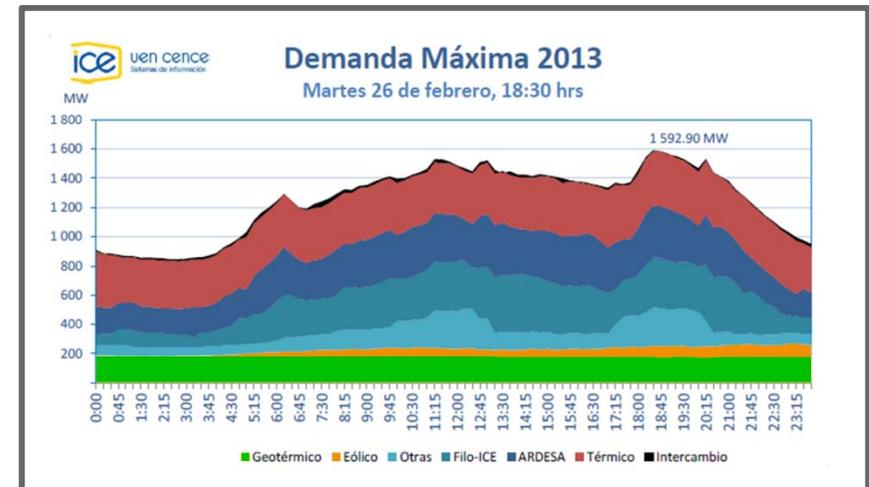


Thermal Generation

2004	1%
2005	4%
2006	6%
2007	9%
2008	7%
2009	5%
2010	7%
2011	9%
2012	9%
2013	11,8%

INSTALLED CAPACITY \neq DEMAND
 \approx 2800 \neq 1593

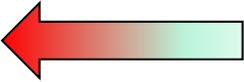
How much can we save?



The energy mix must be robust, it requires strong sources that give reliability to the system

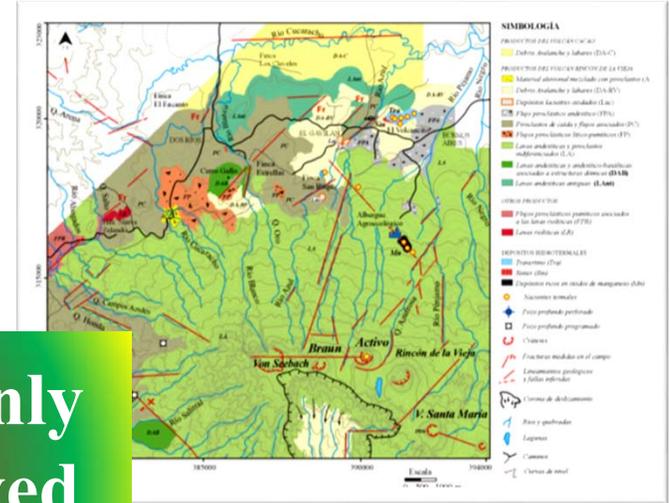
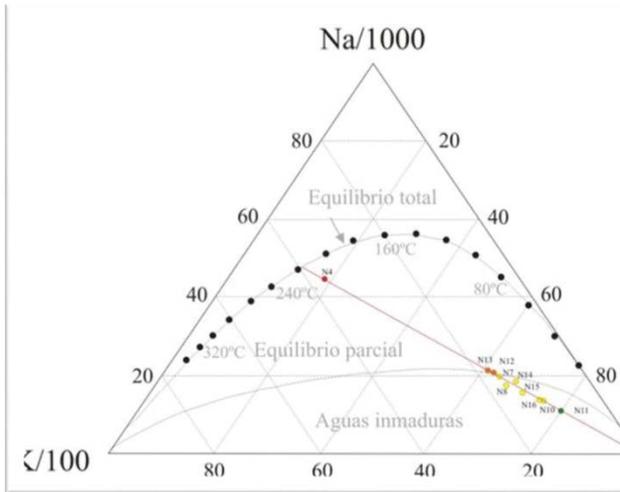
The energy matrix of Costa Rica is based on alternative sources, with a thermal supplement.

Uses of Geothermal Resources in Costa Rica

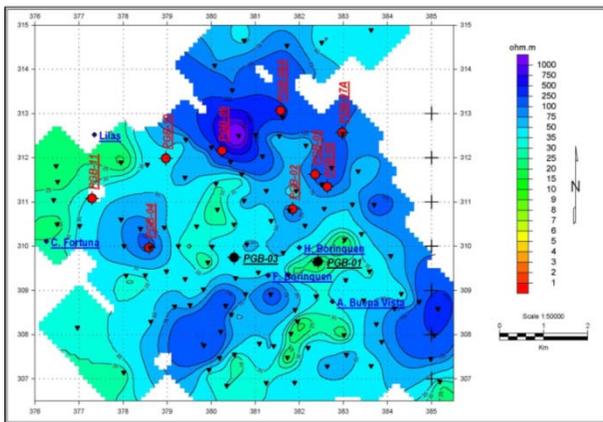
- **Electricity Generation** 
- Agriculture
- Heating of buildings, houses and greenhouses
- Aquaculture
- Pasteurization
- Mining, oil extraction
- Various industrial processes
- Laundry
- **Balneology** 

Steps in the Process of Exploitation of Geothermal Resources

- RECONNAISSANCE
- PREFEASIBILITY
- FEASIBILITY
- DEVELOPMENT
- EXPLOITATION



In Costa Rica only one actor involved in the whole process



Geothermal Energy Status in Costa Rica

GEOHERMAL ENERGY: Legal framework in Costa Rica



- *"It is of public interest the research, exploration and exploitation of geothermal resources of the country, and the activities concerned will be made by the Instituto Costarricense de Electricidad"*
- *"... The geothermal resources are defined as the energy stored in groundwaters that for different geological processes it is at high pressures and temperatures."*



ELECTRICITY MANAGEMENT

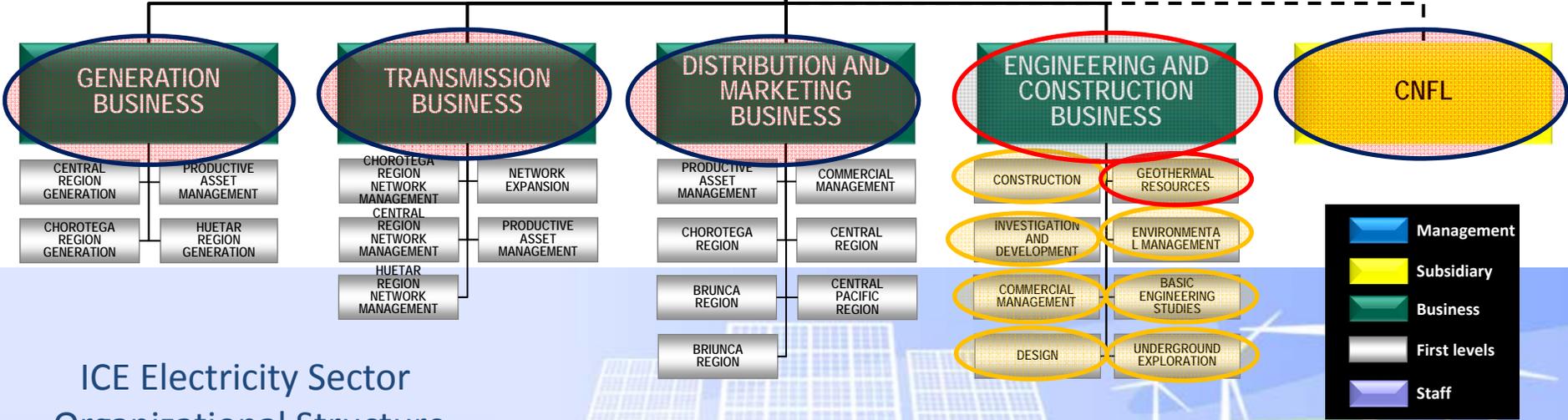
ADMINISTRATIVE ASSISTANCE

NATIONAL POWER CONTROL CENTRE

PLANNING AND ELECTRIC DEVELOPMENT

- OPERATION PLANNING
- OPERATION COORDINATION
- COMMUNICATIONS MANAGEMENT
- COMMERCIAL OPERATION AND TRANSACTIONS

- ENVIRONMENTAL PLANNING
- STUDIES AND PROJECTS
- INVESTMENT STRATEGIES
- SYSTEM EXPANSION

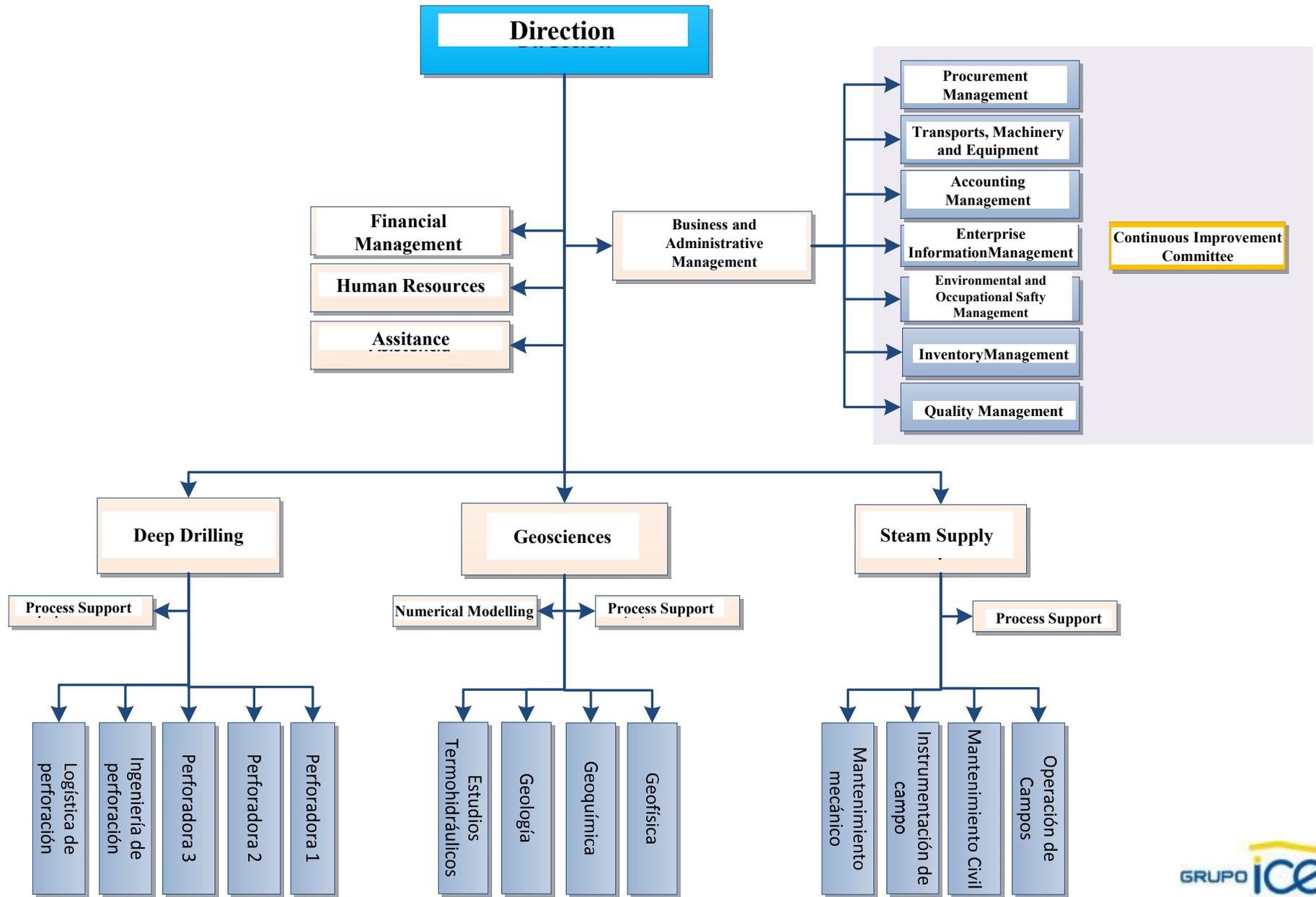


ICE Electricity Sector Organizational Structure

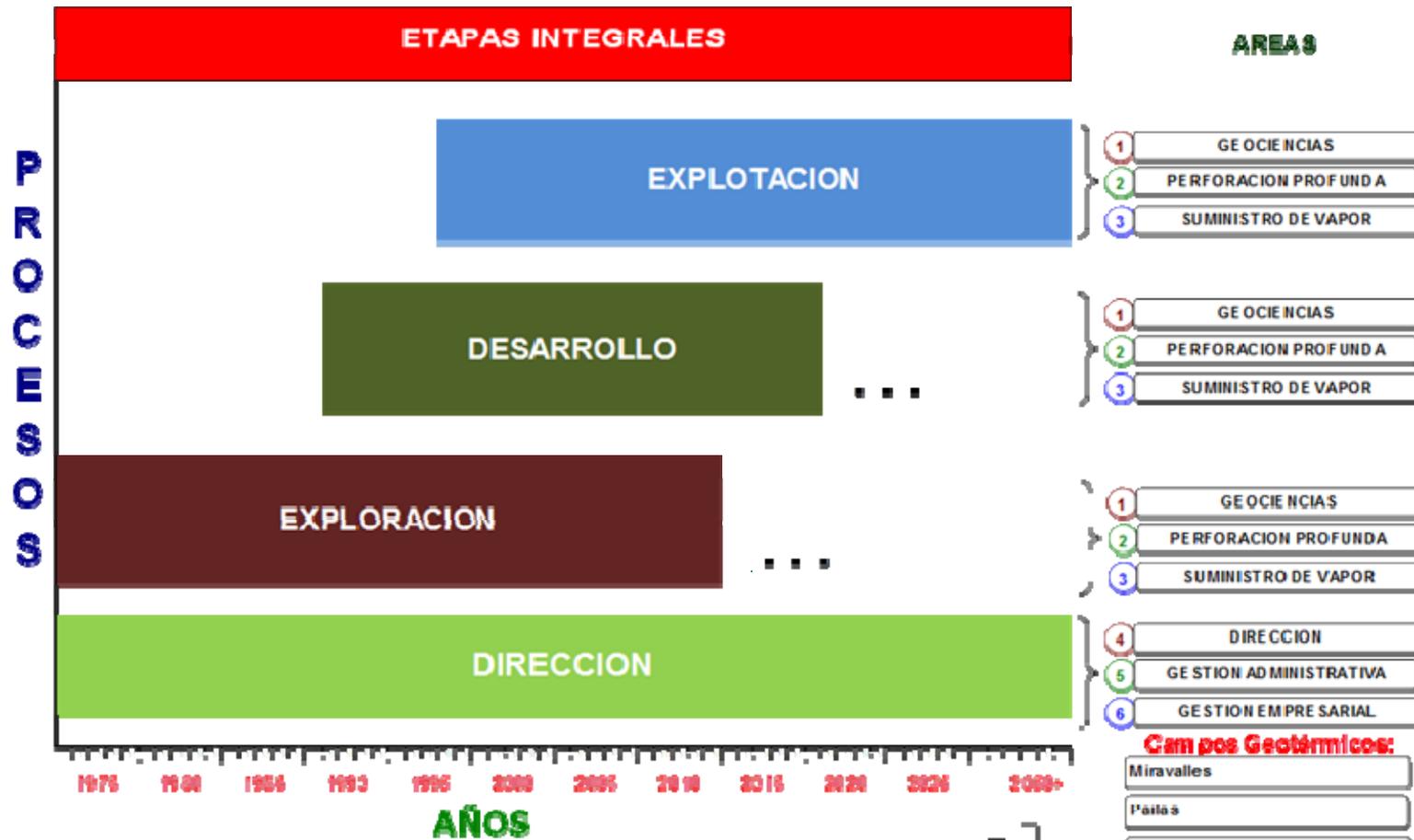
Geothermal Resources Division

- A unit of the Instituto Costarricense de Electricidad (Costa Rican Electricity Institute) responsible for designing and implementing activities related to the exploration, development and exploitation of geothermal resources.
- Whole process: from reconnaissance stage to the delivery of energy resources to ICE and private generation units.

Structural Organization of the Geothermal Resources Division



ESTRATEGIA ACTUAL DE APROVECHAMIENTO DE RECURSOS GEOTERMICOS



①

- Estudios geológicos
- Estudios geofísicos
- Estudios geoquímicos
- Perforación pozos de gradiente
- Estudios Termohidráulicos
- Evaluación geocéntrica del yacimiento
- Modelación del yacimiento
- Caracterización de pozos

②

- Perforación pozos profundos para producción y reinyección
- Limpieza y reparación pozos
- Perforación de pozos para reposición (vapor y reinyección)

③

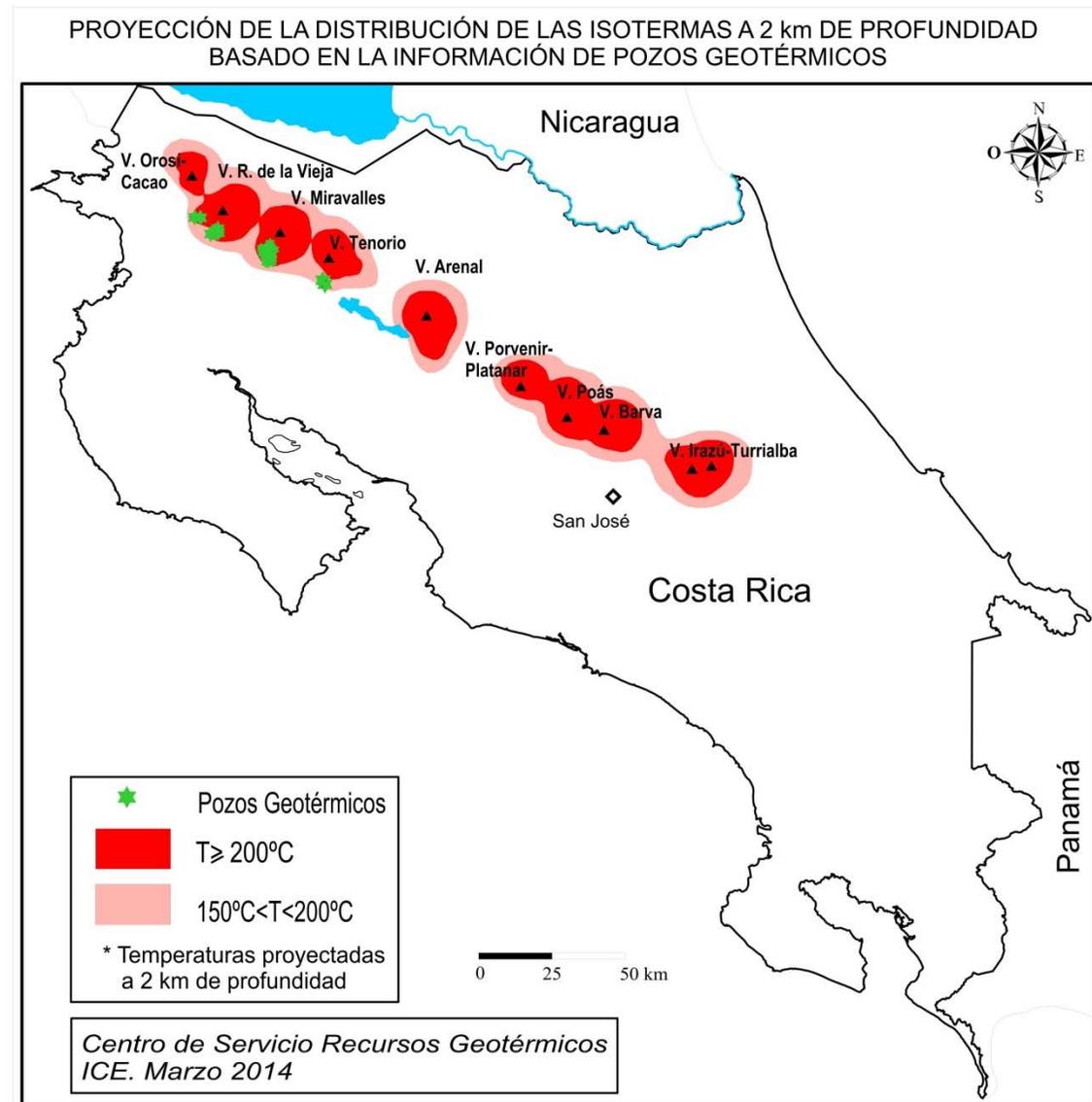
- Operación y mantenimiento de instalaciones superficiales para Sistema Tránsito de Fluidos o las unidades generadoras.
- Instalaciones eléctricas, instrumentales y conectividad del pozo

Campos Geotermicos:

- Miravalles
- Pataca
- Boquiquen
- Pocosol y Otros

Potential Geothermal Areas

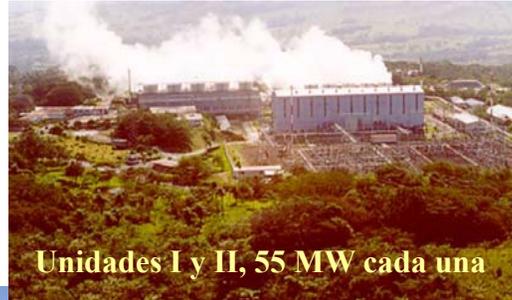
Potential geothermal areas in Costa Rica are associated with volcanic systems, which are mostly associated with environmental protected areas.



Geothermal Fields in Operation

Miravalles Geothermal Field:

- In operation since 1994
- 163,5 MW installed



Unidades I y II, 55 MW cada una



Unidad III, 29,5 MW



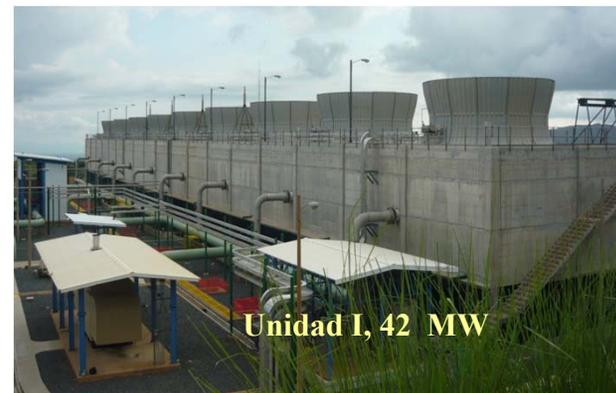
Unidad V, 19 MW



Unidad Boca de Pozo, 5 MW

Las Pailas Geothermal Field:

- In operation since 2011
- 42,5 MW installed

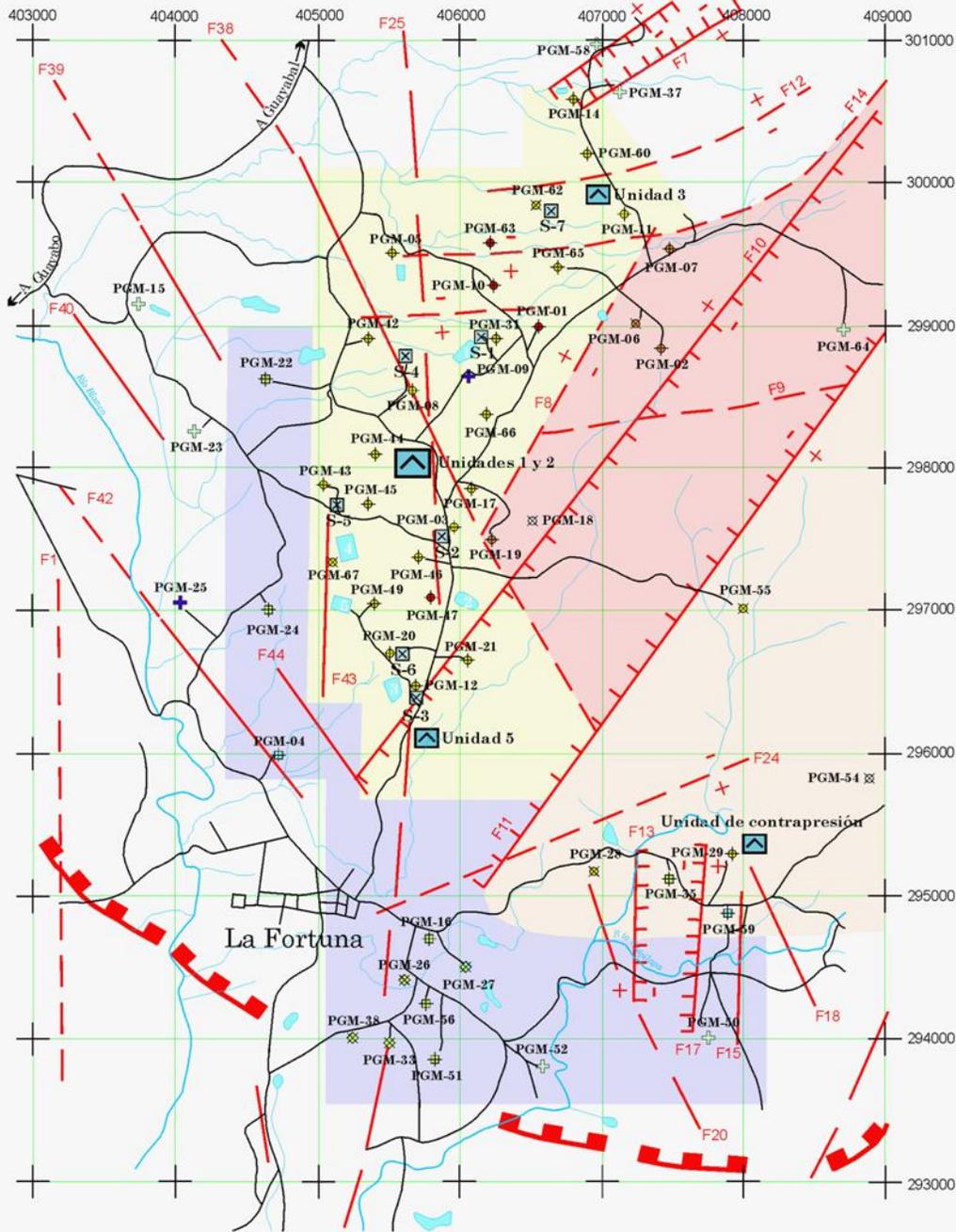


Unidad I, 42 MW

Planta Pailas I

The Miravalles Geothermal Field

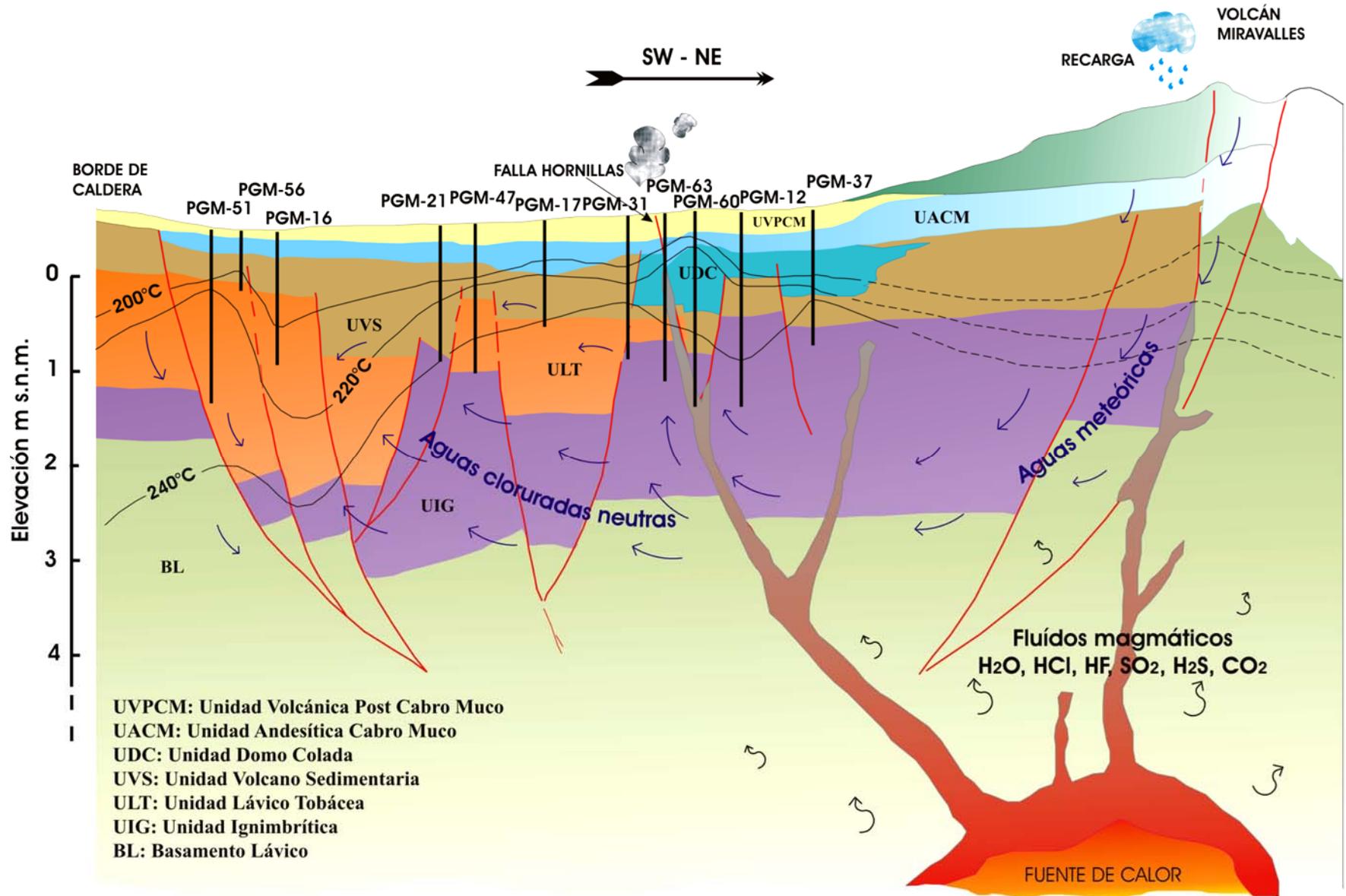
CAMPO GEOTÉRMICO MIRAVALLS

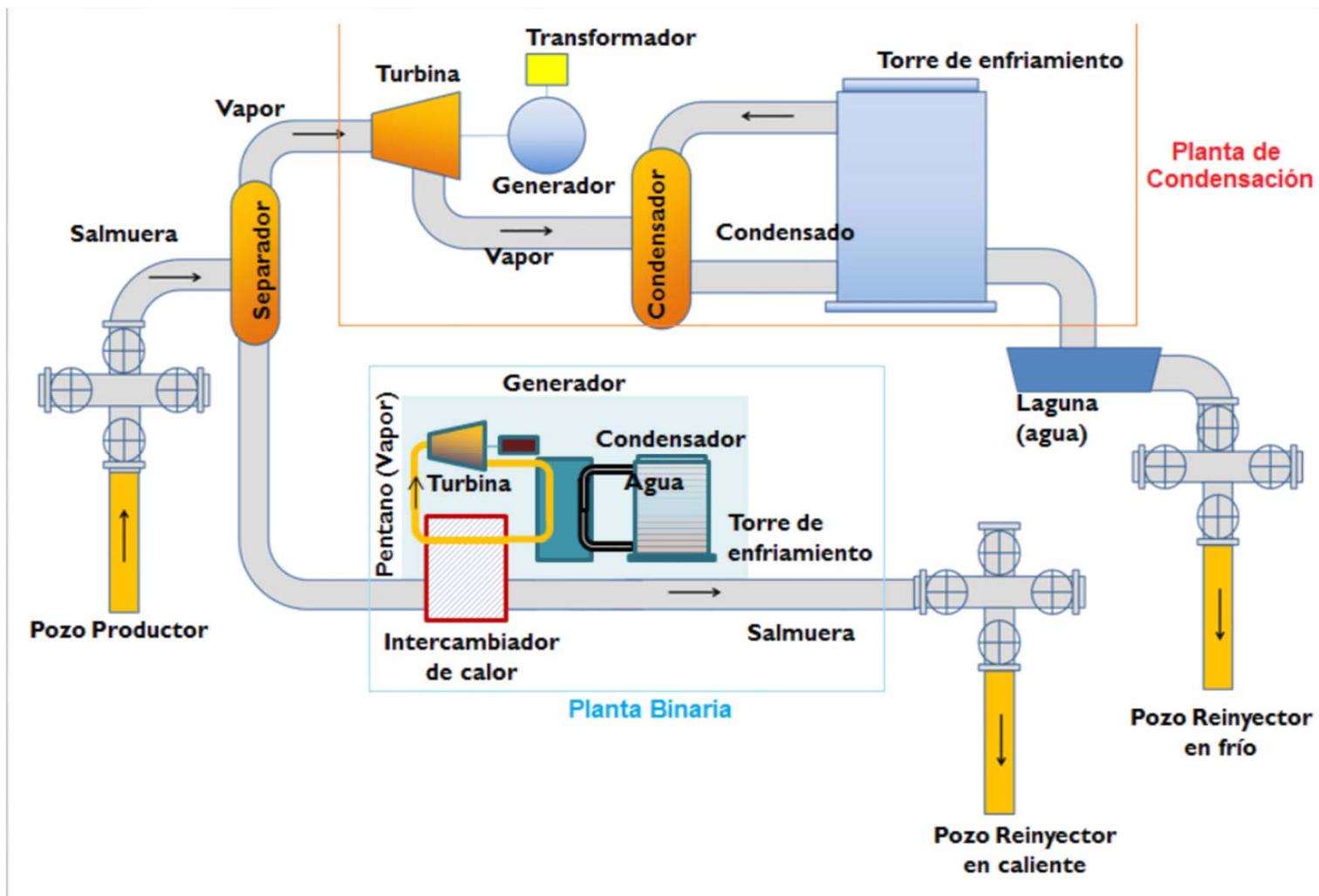


SIMBOLOGÍA

- Pozo productor neutro
- Pozo productor ácido
- Pozo de reserva neutro
- Pozo de reserva ácido
- Pozo productor fuera de servicio
- Pozo reinyector en caliente
- Pozo reinyector en frío
- Pozo de monitoreo
- Pozo exploratorio
- Pozo a perforar
- Borde caldérico
- Fallas y alineamientos
- Falla normal
- Unidad de generación
- Satélite de separación
- Laguna
- Zona productora principal
- Zona bicarbonatada
- Zona ácida
- Zona de reinyección



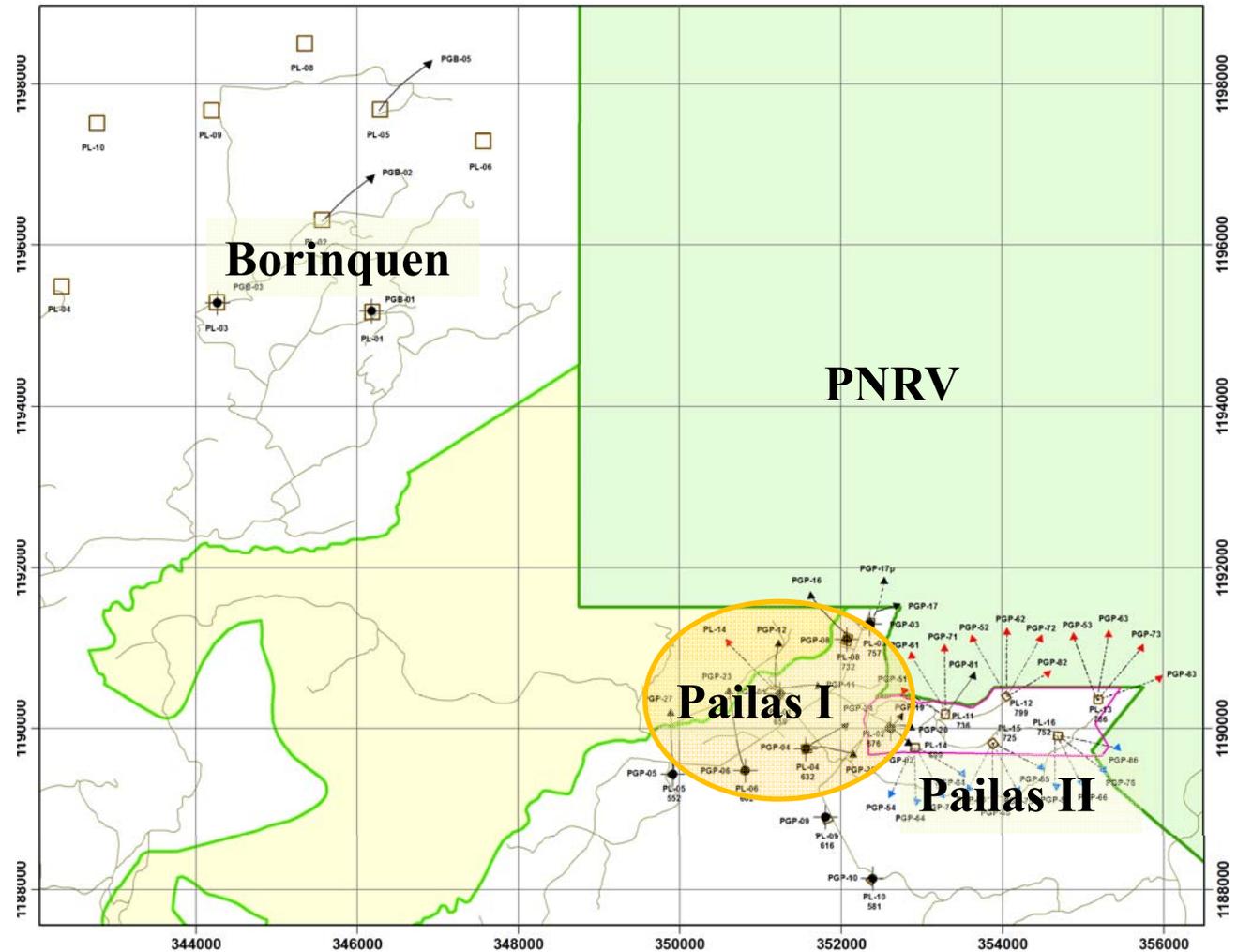




The Las Pailas Geothermal Field

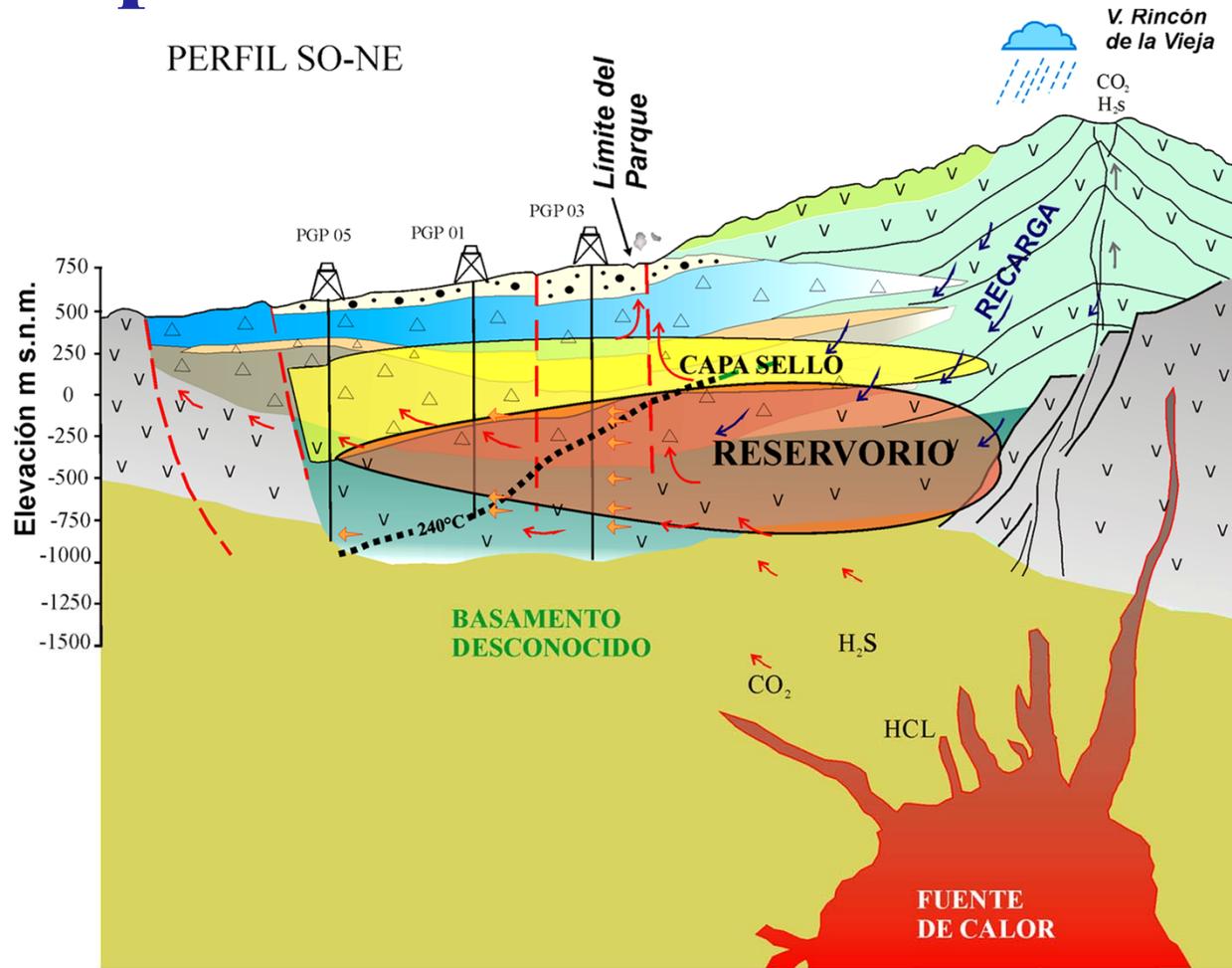
Geothermal Fields in Exploitation: Las Pailas I

- Pailas II (Expansion Pailas Field – 55 MW)



Geothermal Fields in Exploitation: Las Pailas I

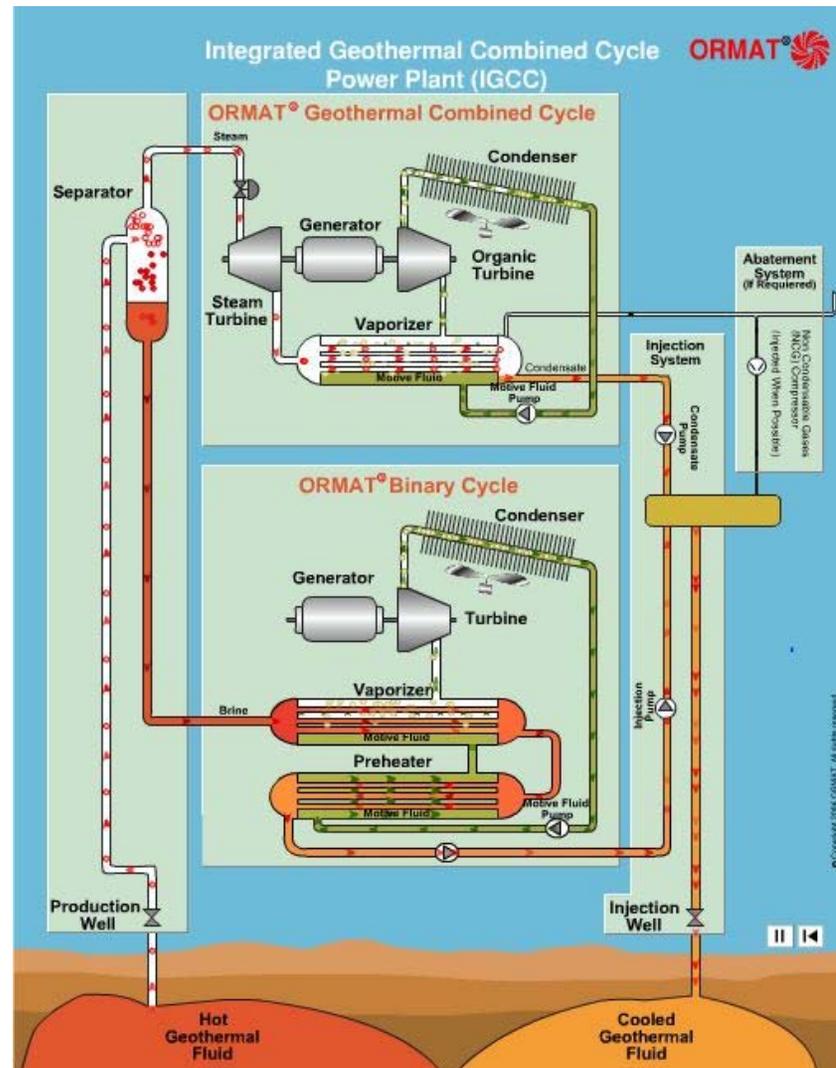
PERFIL SO-NE



Leyenda

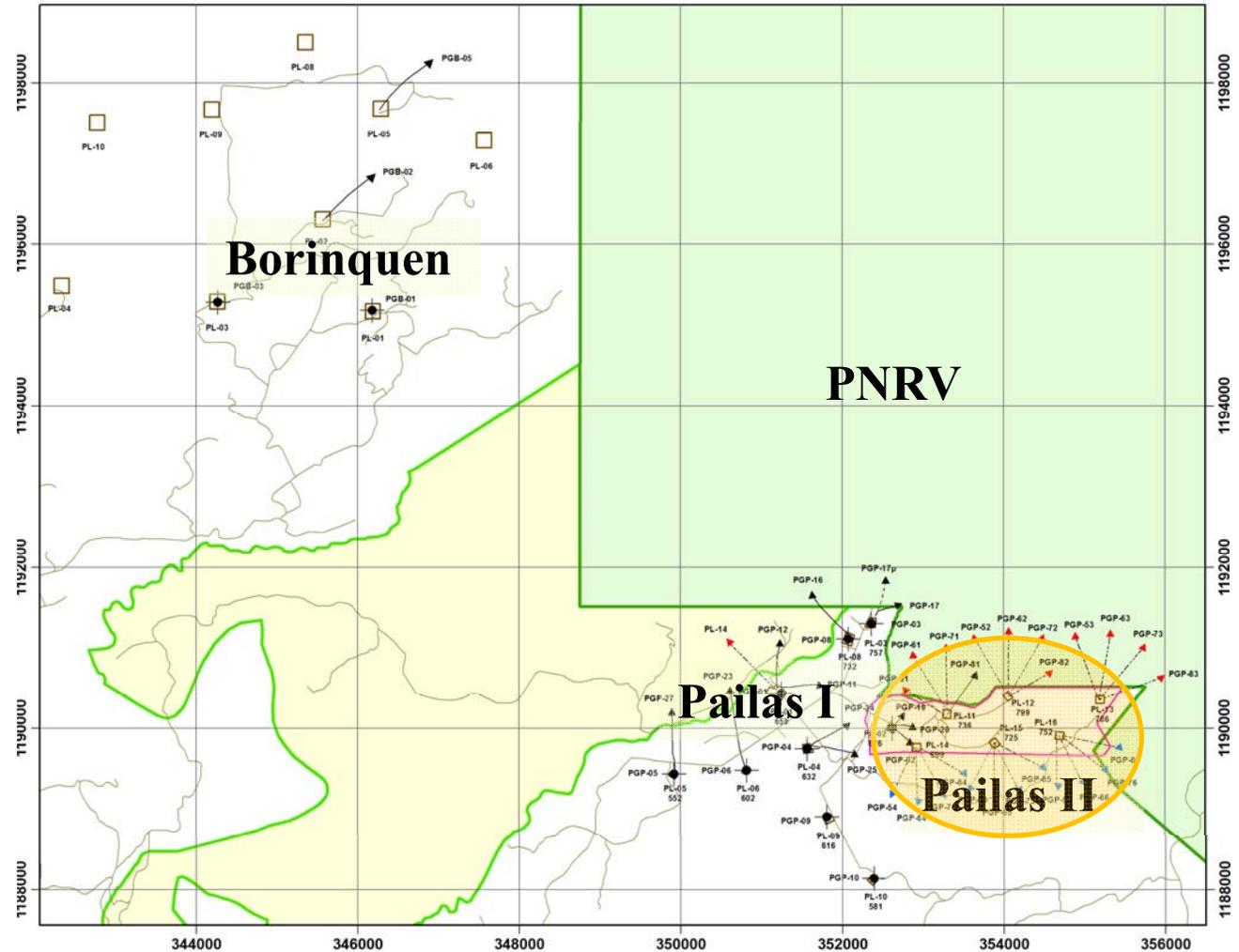
- | | | |
|--------------------|---|---|
| Fallas inferidas | Depósitos laháricos con lavas y tobas asociadas | Depósitos tobáceos y lavas subordinadas |
| Zonas permeables | Toba pumítica | Flujos de lava |
| Isotherma de 240°C | Toba pumítica con trazas de biotita | Lavas del borde caldérico |

Geothermal Fields in Exploitation: Las Pailas I

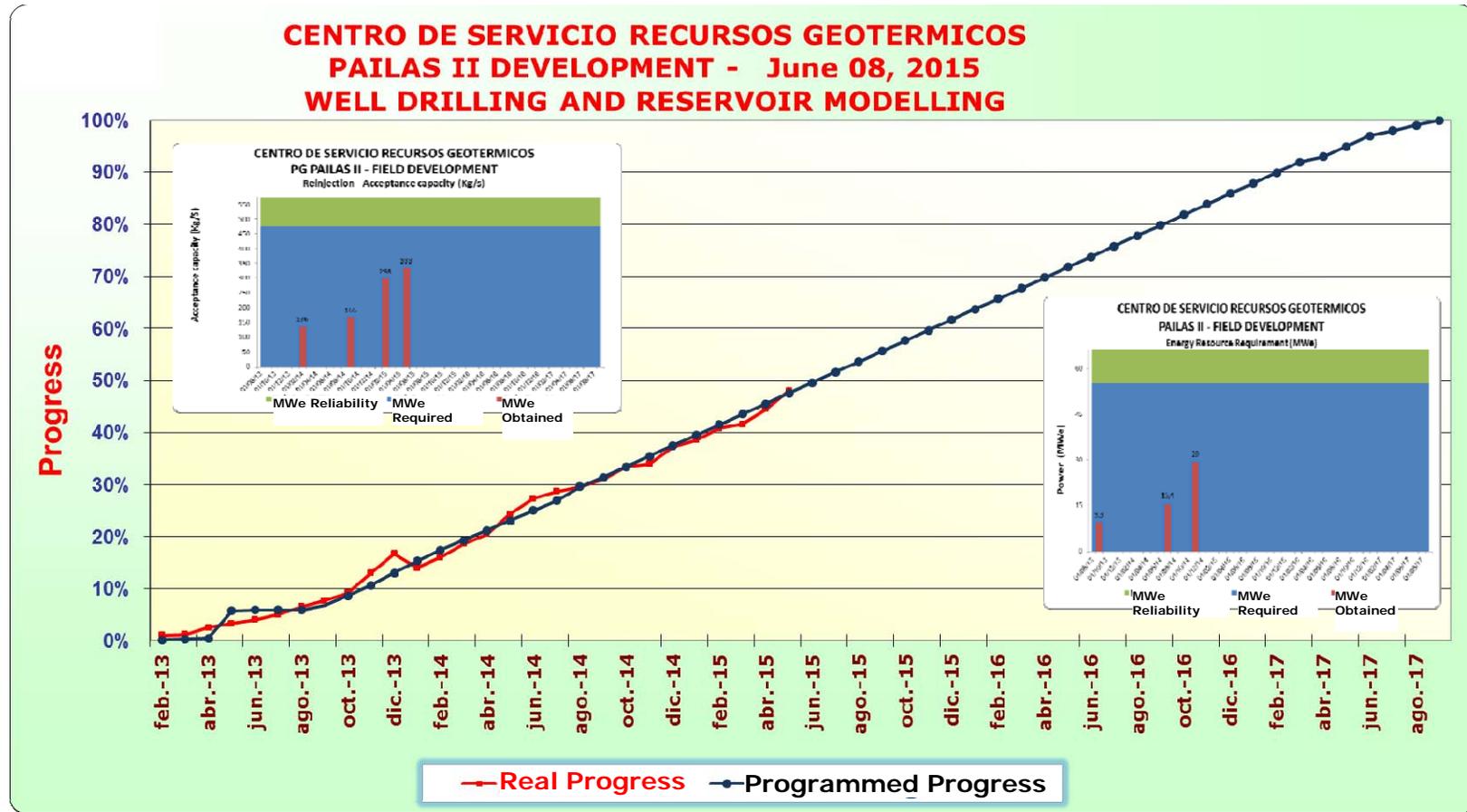


Actual Developments: Las Pailas II

- Las Pailas II
(Expansion Las Pailas Field – 55 MW)

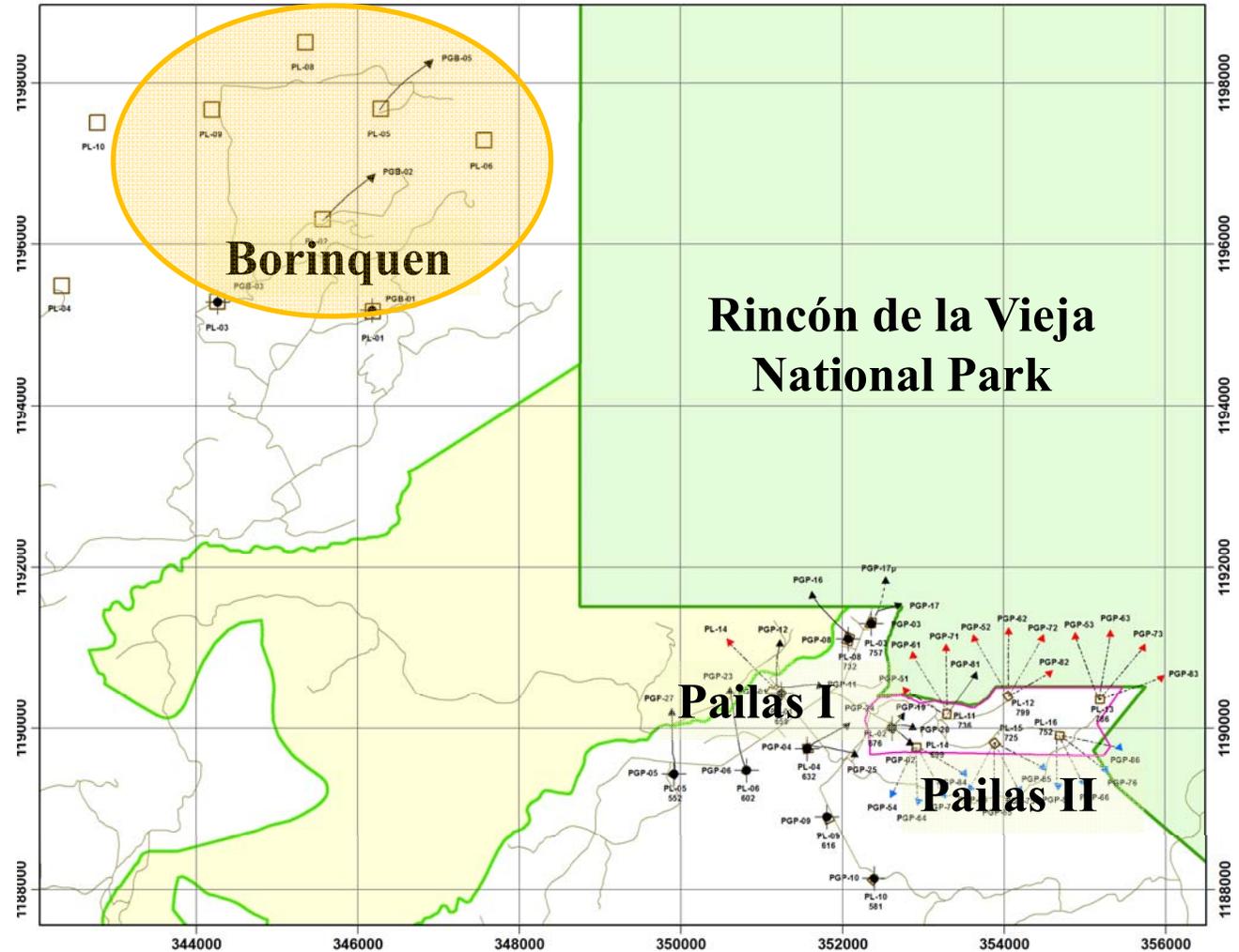


Real and Projected Development of Works

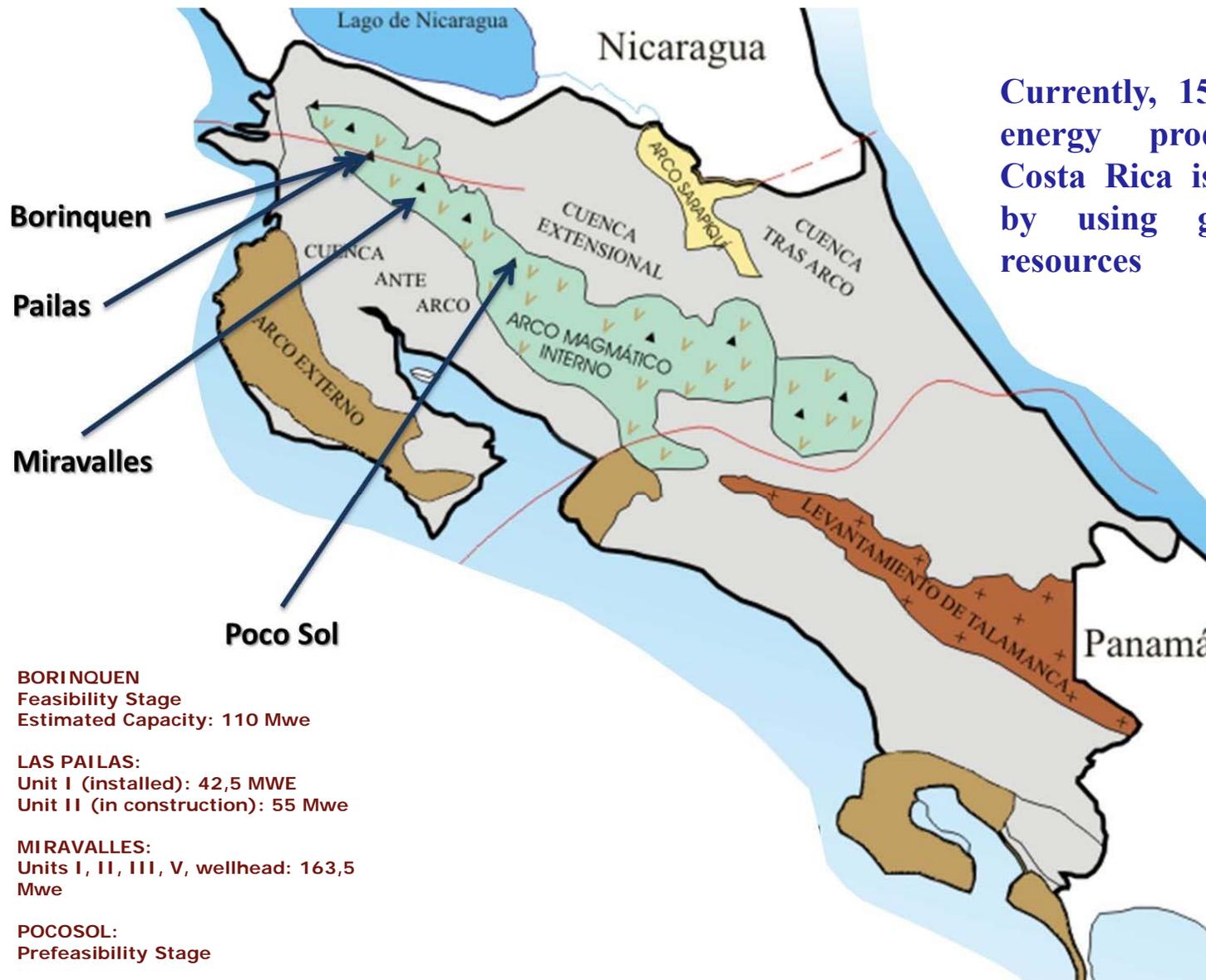


Current developments: Borinquen

- Borinquen
(Installation of two units of 55 MW each)



Current Status of Geothermal Areas in Costa Rica



Currently, 15% of the energy produced in Costa Rica is provided by using geothermal resources

Use of Geothermal Resources

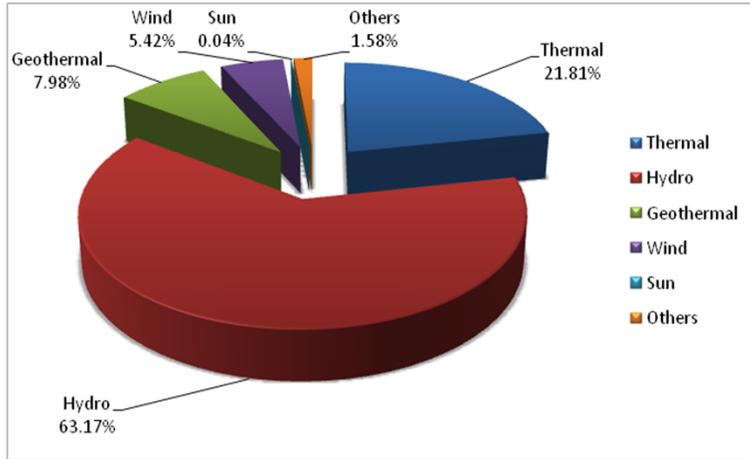
- Sustainability
- Cultivation
- Conservation



Rational and conscious use of resources that allows their use under a regime of stability (away from exhaustion or collapse)

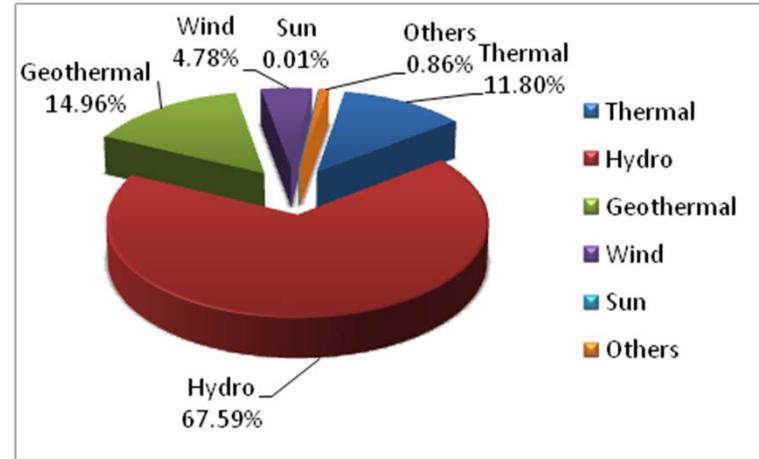
Why Use Geothermal Resources?

Installed Capacity - 2013

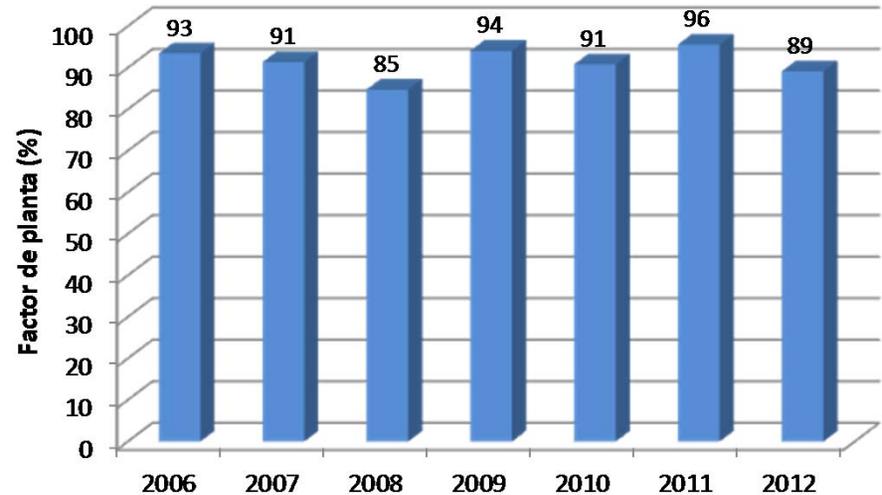
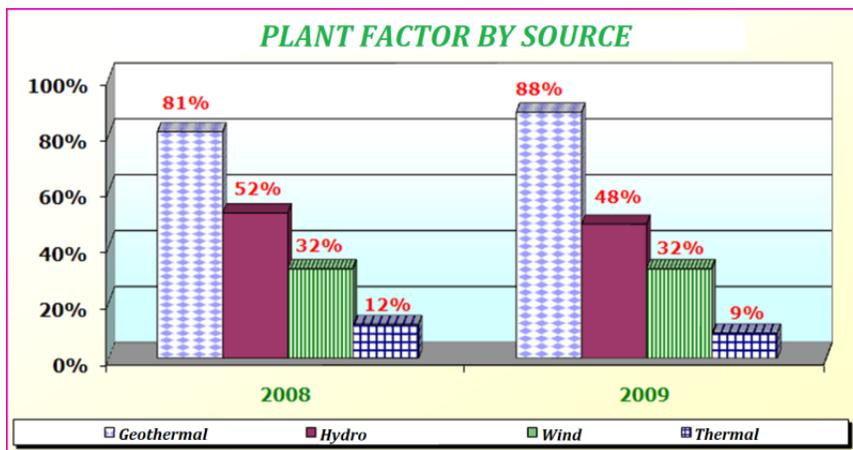


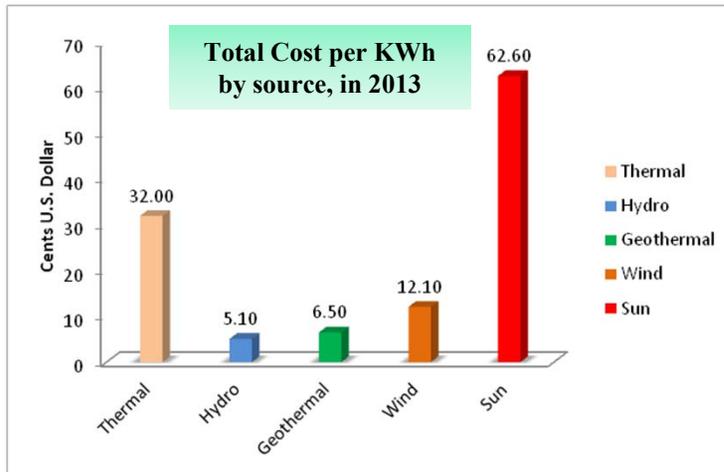
Reliable Energy

Generation - 2013

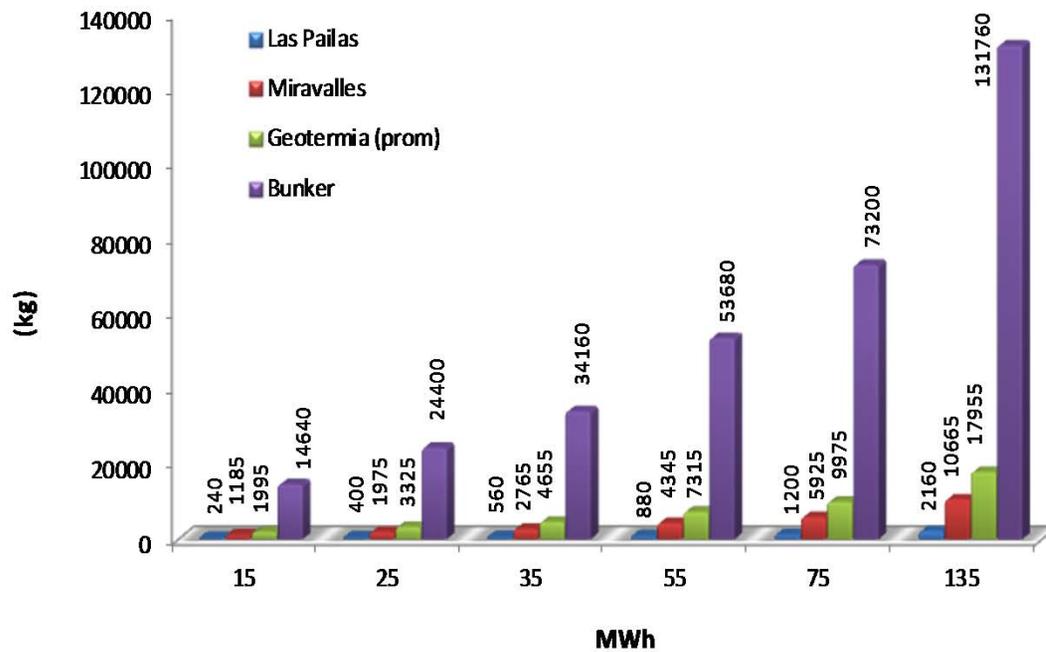
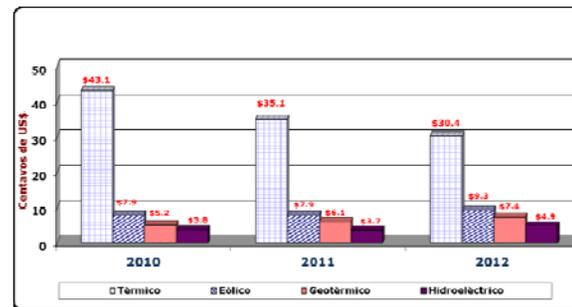


Efficient Energy





Low Cost Energy



Clean Energy
Generation of CO2
equivalent

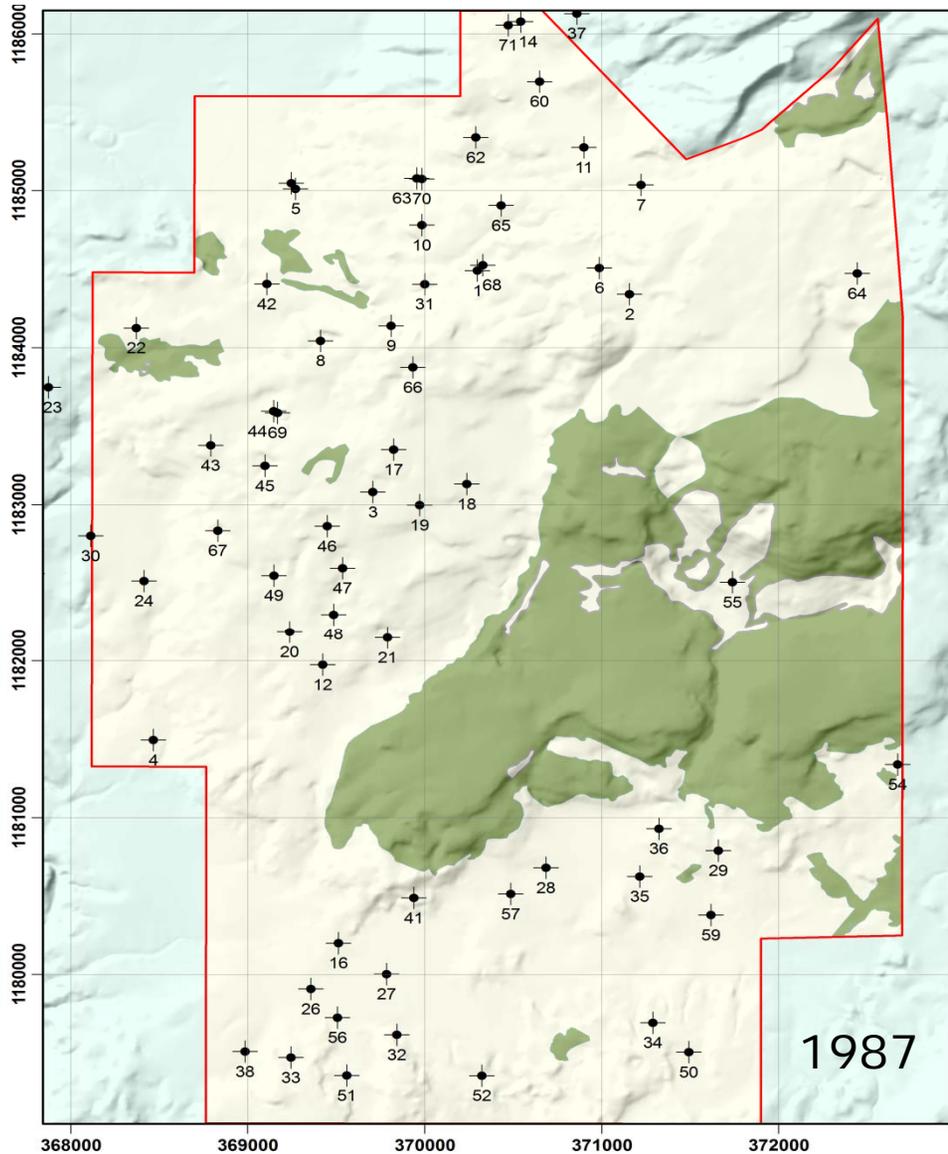
Coexistence with the Environment



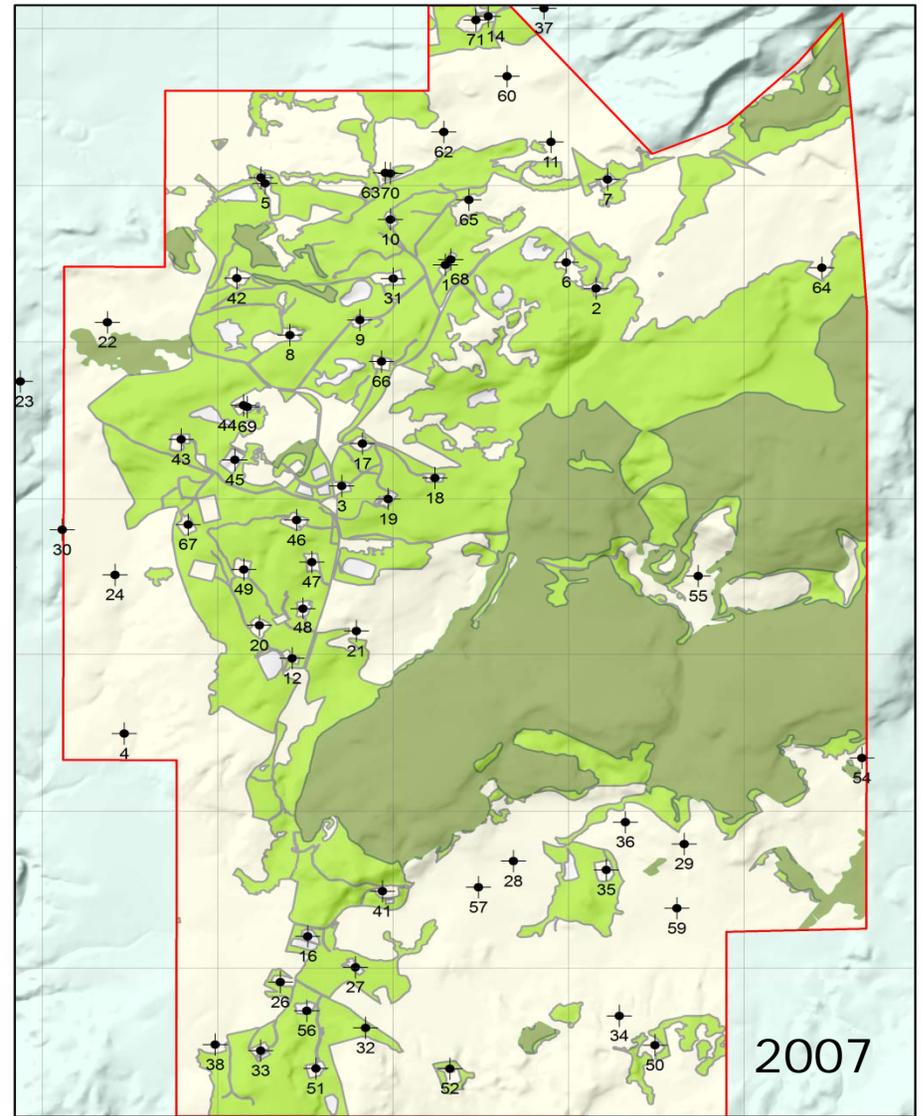


**Miravalles Geothermal Field,
Separation Unit I**

Recovery of the Forest Area



Forest Cover in 1987
600.33 Ha



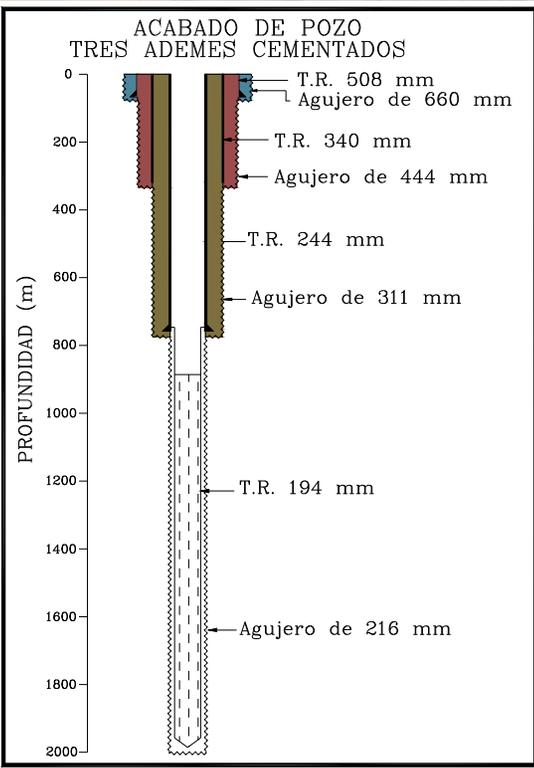
**Difference Between Forests Covers
(Reforested Area)**
880.84 Ha

Recovery of the Forest – Las Pailas I

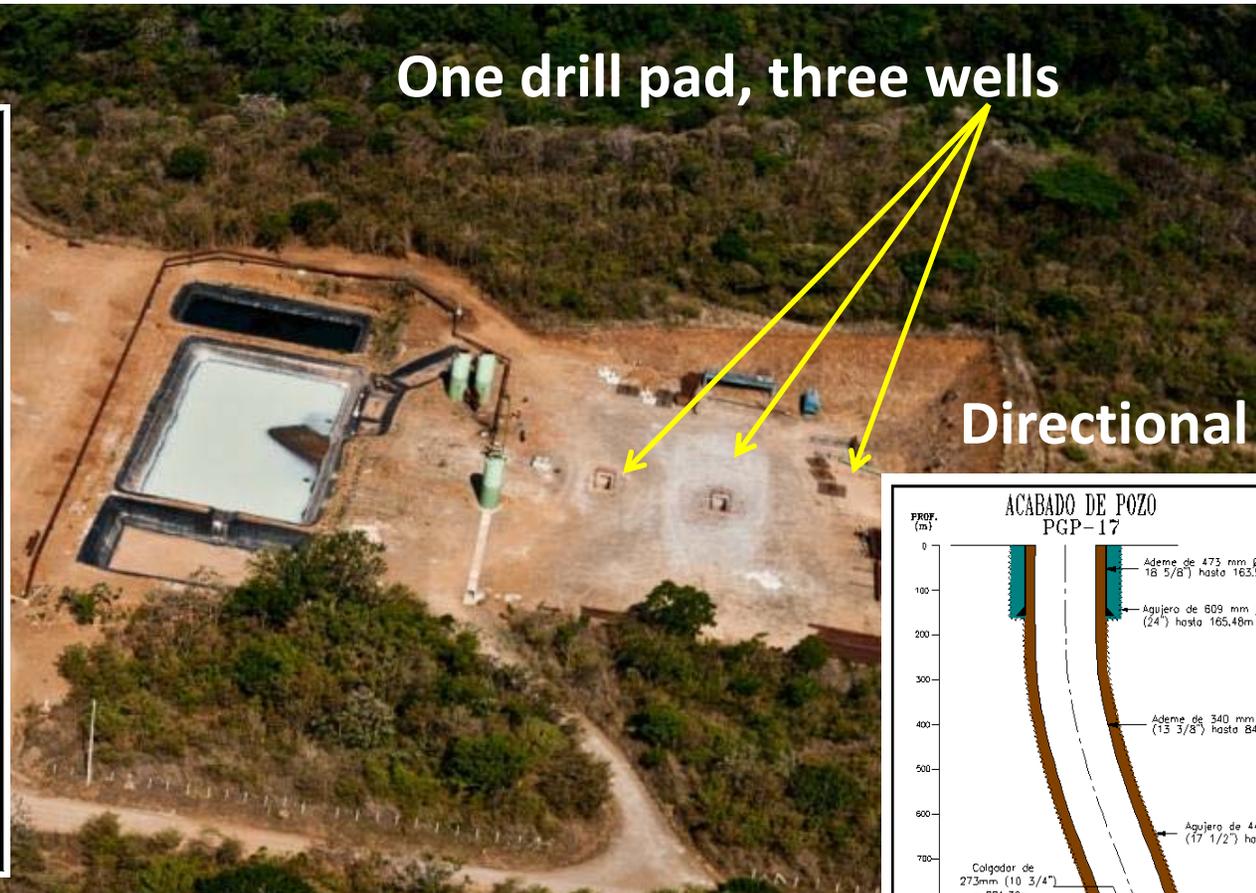


Using New Drilling Technologies

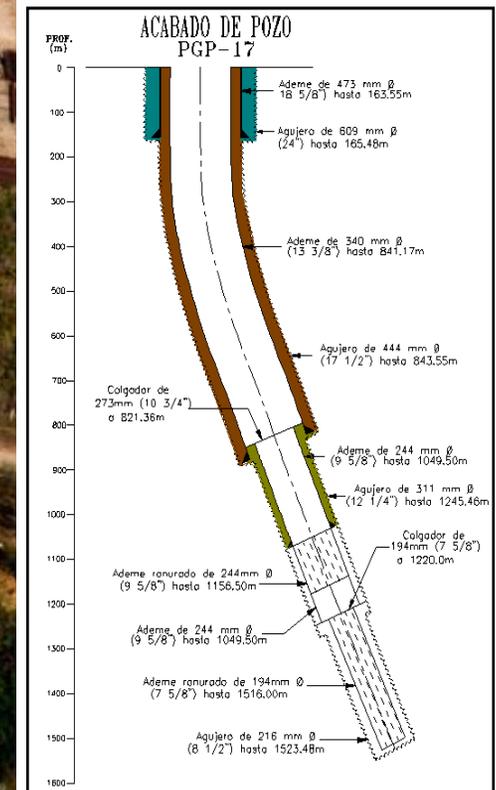
Vertical



One drill pad, three wells



Directional



Changing technology from vertical drilling to directional drilling allows a significant reduction of environmental impacts, thereby reducing the intervention in areas up to 300%.

The number of platforms, access roads, pipelines, sewers, etc. is reduced

Las Pailas II Sector



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Image © 2014 DigitalGlobe

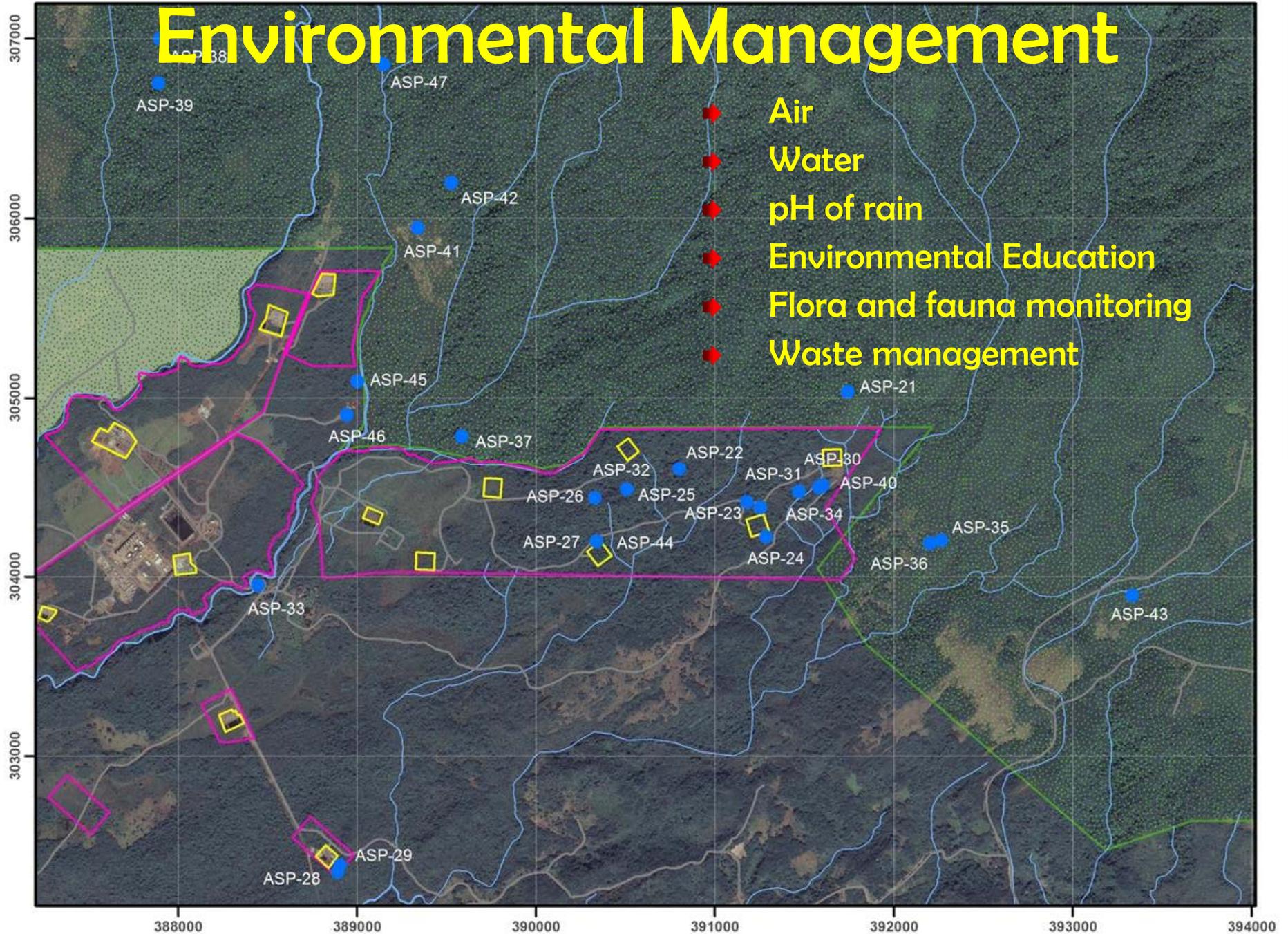
Google

1970

10°45'42.16" N 85°21'33.23" O elevación 659 m alt. ojo

Environmental Management

- Air
- Water
- pH of rain
- Environmental Education
- Flora and fauna monitoring
- Waste management





**Thank you
for your
attention!**



**Geothermal energy,
a sustainable alternative**