



Costa Rica, 25 Years of Geothermal Energy and Future Plans

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Content

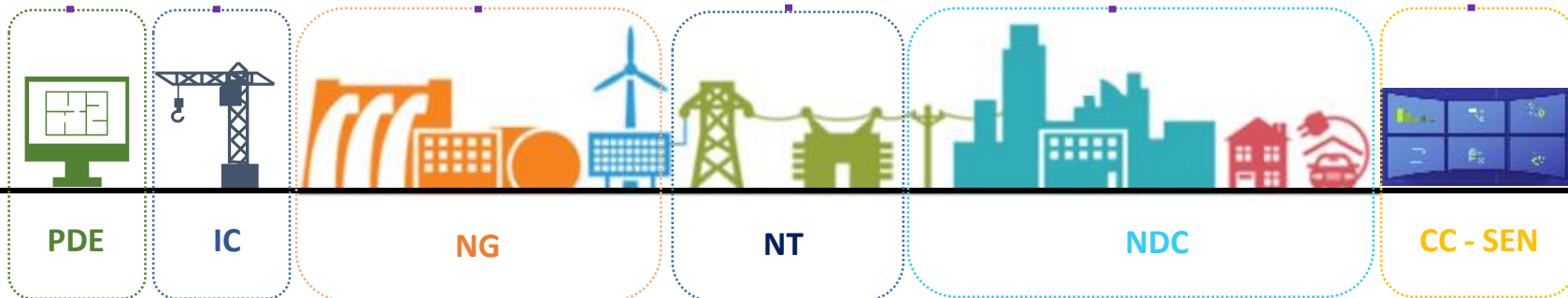
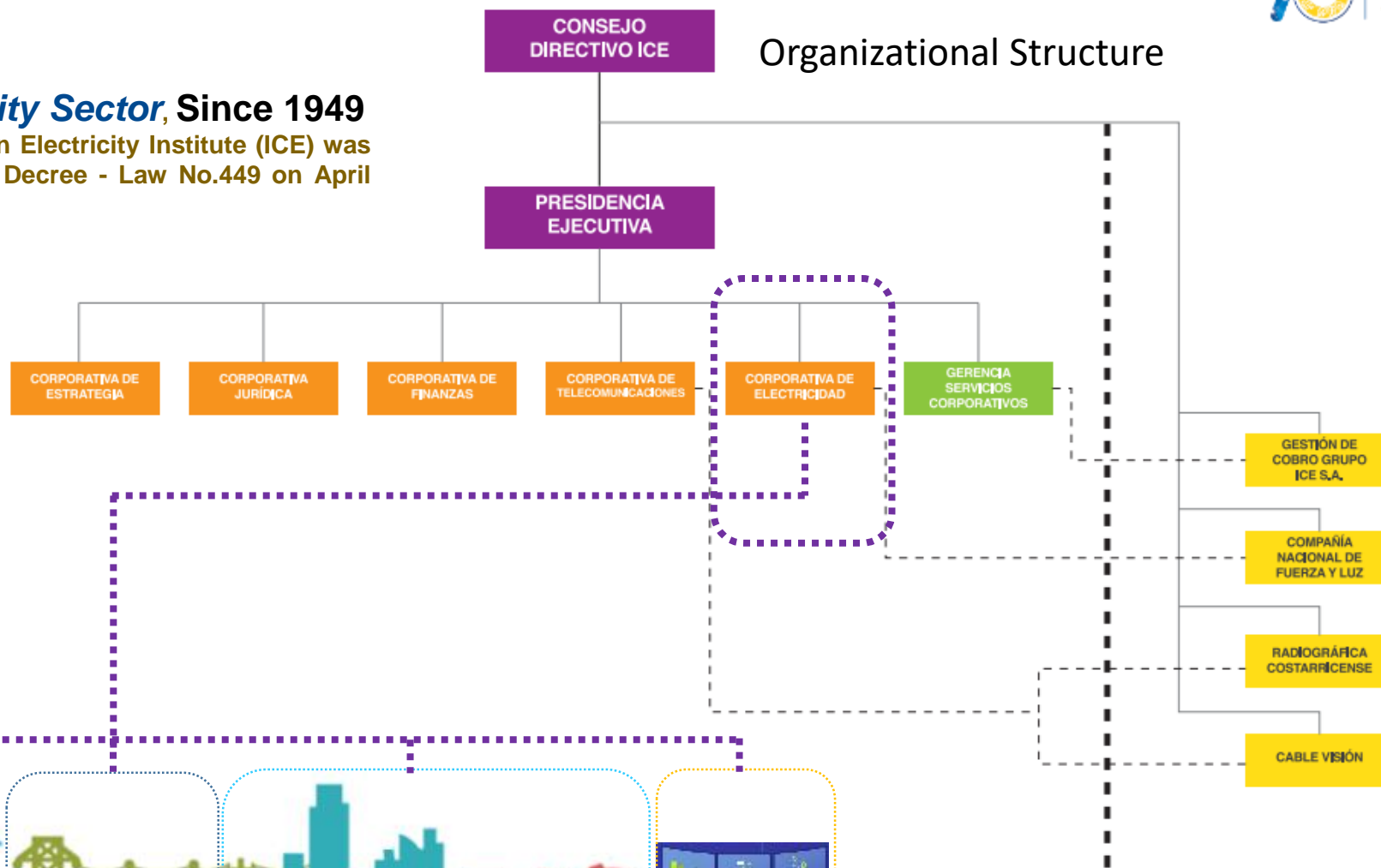
- 1 Overview of ICE Group
- 2 Electric Matrix of CR
- 3 Geothermal: Legal framework in Costa Rica
- 4 Our capabilities
- 5 Geothermal Resources Development in CR
- 6 Geothermal Projects portfolio
- 7 Geothermal Services



1. Overview of ICE Group



Electricity Sector, Since 1949
 Costa Rican Electricity Institute (ICE) was created by Decree - Law No.449 on April 8th 1949.



Telecom Sector since 1963



are news in the world



98.6 % Generation of Clean Energy 2018

+80%

Installed Capacity is Renewable
(Green energy sources)

Renewable 2018

Hydro: 73.47%

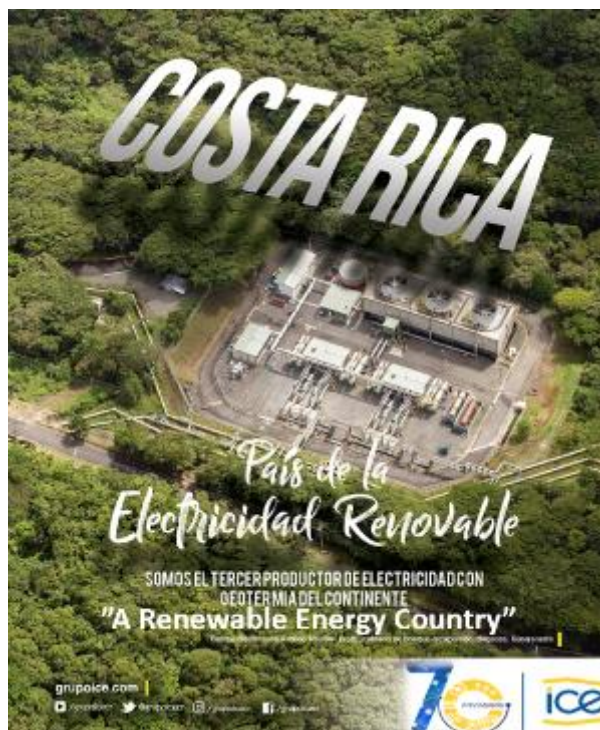
Geothermal: 8.53%

Wind: 15.83%

Biomass: 0.68%

Solar: 0.09%

Non Removable (Thermal): 1.40%



2016: 1st place on Wind Power in
Central American and Caribbean and
3rd in LA region

300+ (2018)

345+ (2017)

240+ (2016)

75+ (2015)

days of Clean Energy área news in the World

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3. Geothermal: Legal framework in Costa Rica since 1976

- -" 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."

FACULTY OF THE COSTA RICAN ELECTRICITY INSTITUTE FOR THE INVESTIGATION, EXPLORATION AND EXPLOITATION OF GEOTHERMAL RESOURCES IN THE COUNTRY

(Law No. 5961 of December 6, 1976)

(Gazette No. 244 of December 22, 1976)



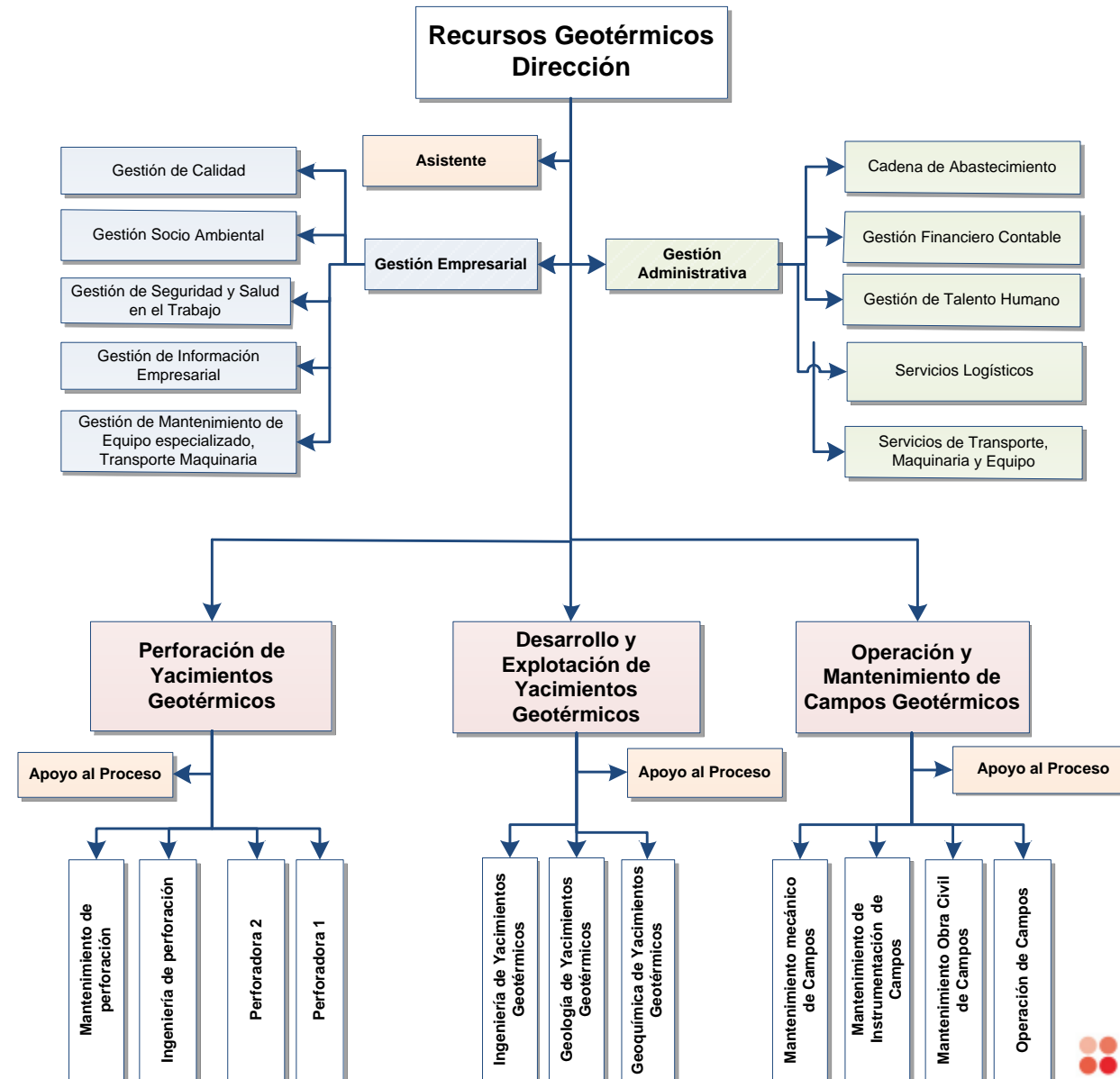
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4. Ours capacity - Integrated Reservoir Management

Electricity Corporate Direction

Conceptualize, design and execute the strategies and actions that allow, under a concept of sustainability, the Exploration, Development and Exploitation of geothermal reservoirs, for commercial use in the generation of electricity. The above with technologies, planning, organization and adequate controls, in harmony with the environment.

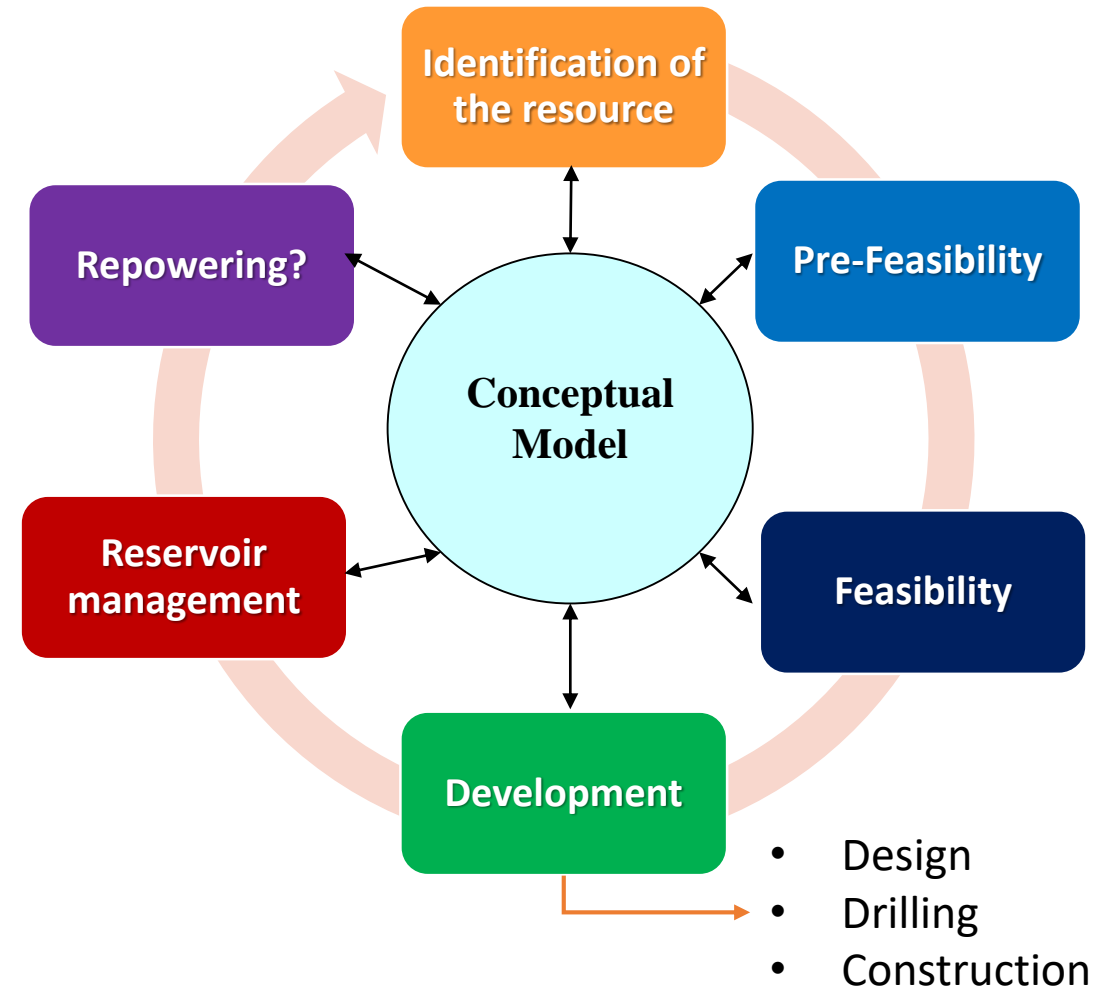
Process that comes from the stages of recognition of the potential zones of geothermal interest, to the supply of the energy resource to the power plants.



Integrated Reservoir Management

- A specialized group manages all stages in an integrated manner
- Low turnover of personnel, allows highly specialized and experienced staff.
- Since the ICE is a state-owned company, a long-term exploitation of the resource is sought.

Sustainable exploitation



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5. Geothermal Resources Developments in Costa Rica



Geothermal Resources: fields



1 Alfredo Mainieri P. Geothermal Field
(Exploitation since 1994)
 Installed cap. (154,5 MW)
 Estimated pot. (164 MW)
 CapEx \$ 3.7 Mills/MW

2 Pailas I Geothermal Field
(Exploitation since 2011)
 Installed cap. (42.5 MW)
 CapEx \$ 5.8 Mills/MW

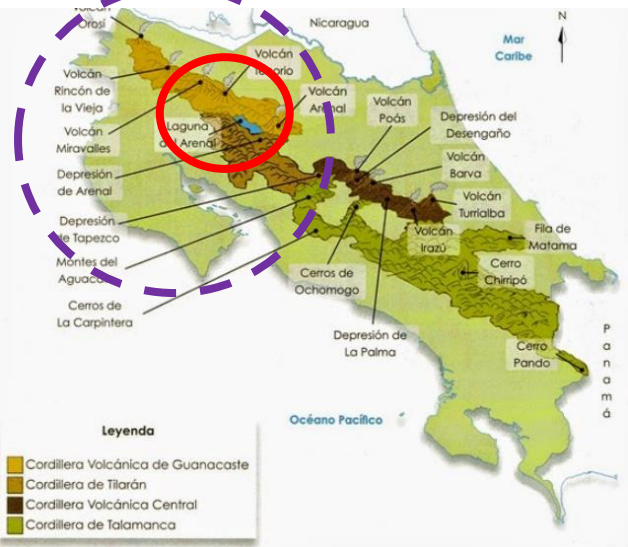
3 Pailas II Geothermal Field
(Exploitation since 2019-7)
 Installed cap. (55 MW)
 CapEx \$ 4.47 Mills/MW

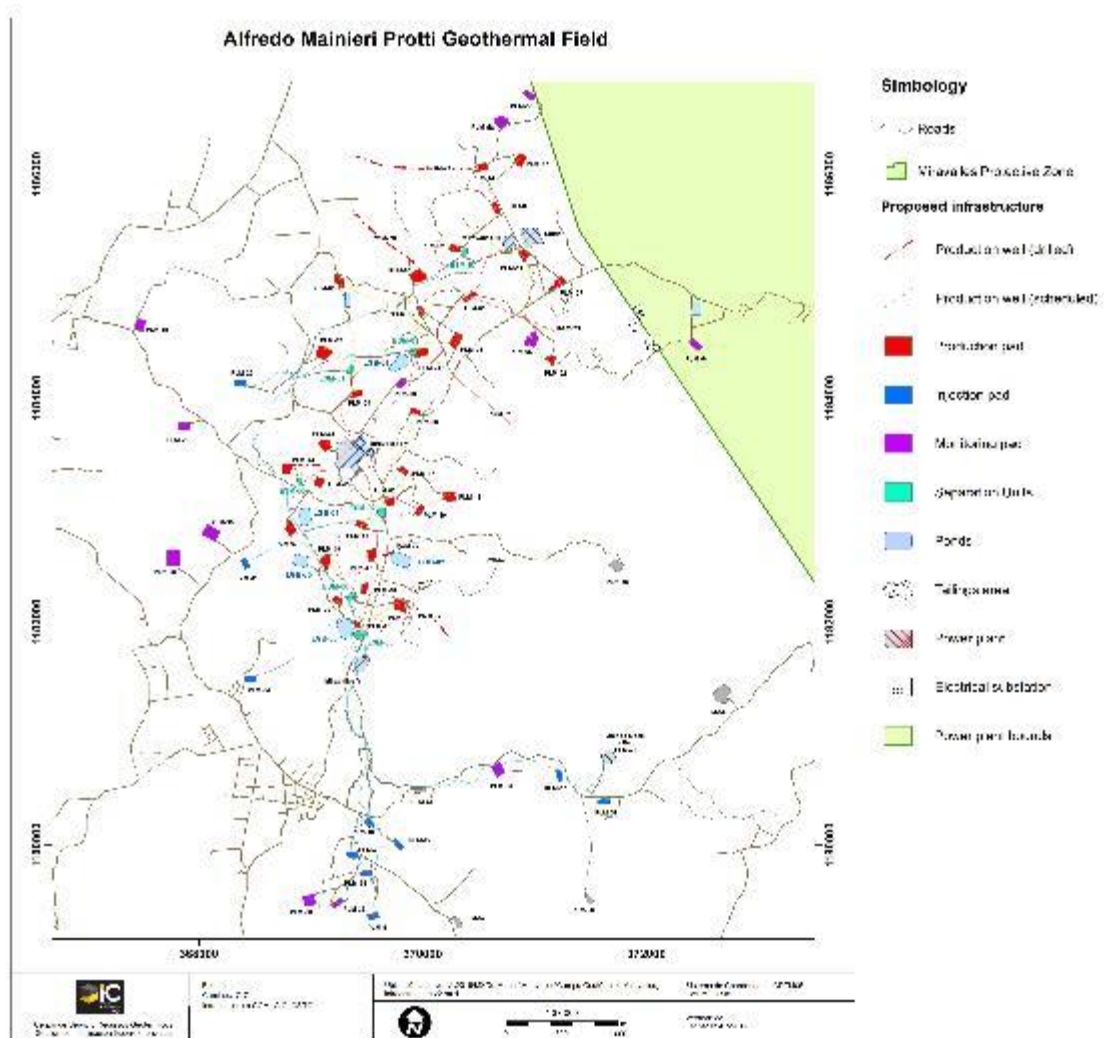
4 Borinquen I Geothermal Field
(Development)
 Proposed cap. (55 MW)
 CapEx \$ 5.9 Mills/MW

5 Borinquen II Geothermal Field
(Future Development)
 Proposed cap. (55 MW)

Average cost of Geothermal Generation
7.18 c\$/ kWh

Rincón de la Vieja Volcano
 Estimated potential:
137 MW





Alfredo Mainieri Protti Geothermal Field

- Miravalles I Star-up 1994
- Back pressure unit Start-up 1995
- Miravalles II Star-up 1998
- Miravalles III Star-up 2000
- Miravalles V Star-up 2003
- 154.5 MW installed
- Length of networks
- Aqueduct: 17.21 km
- Cold reinjection system: 28.17 km
- Fiber optic: 14.5 km
- Electrical networks: 29,780 km
- High temperature pressurized piping: 48,512 km.
- 5 collection ponds
- 7 separating stations
- 61 wells

MIRAVALLLES GEOTHERMAL POWER PLANT

Costa Rica

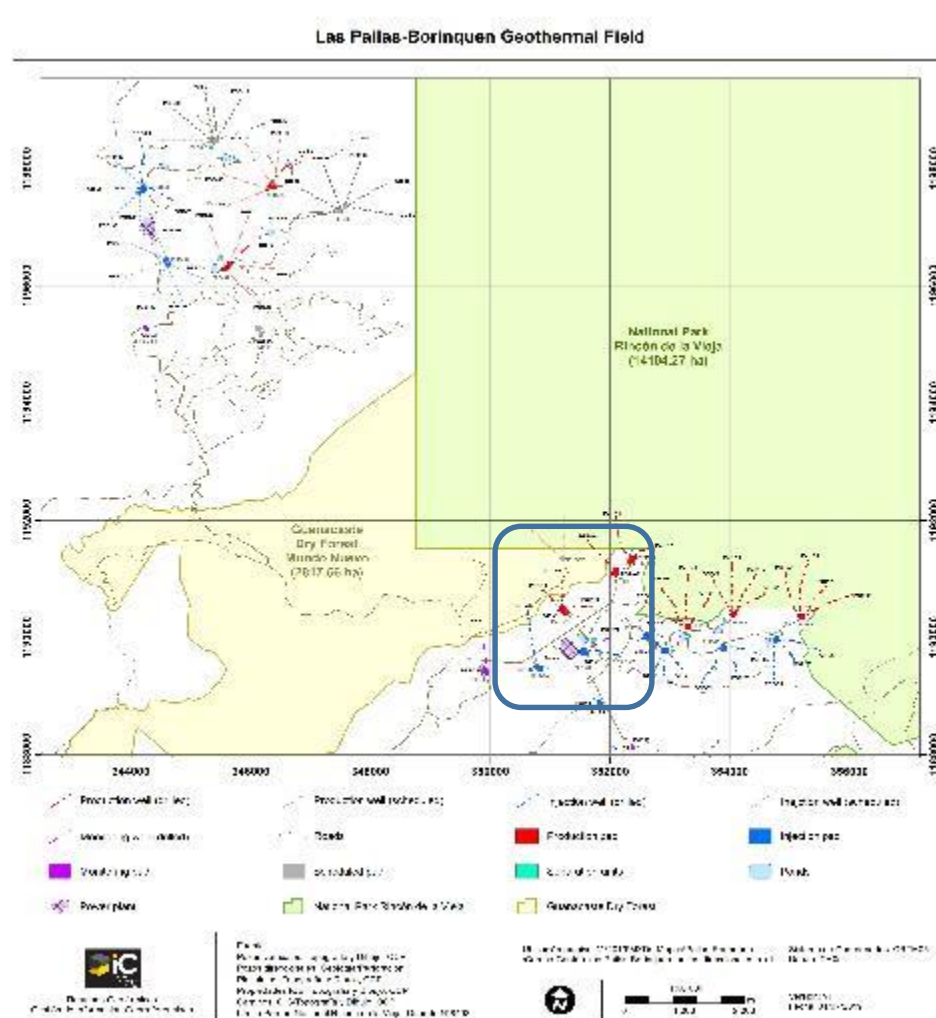


**Celebrating
25 Years of Operation**

GRUPO **ice**

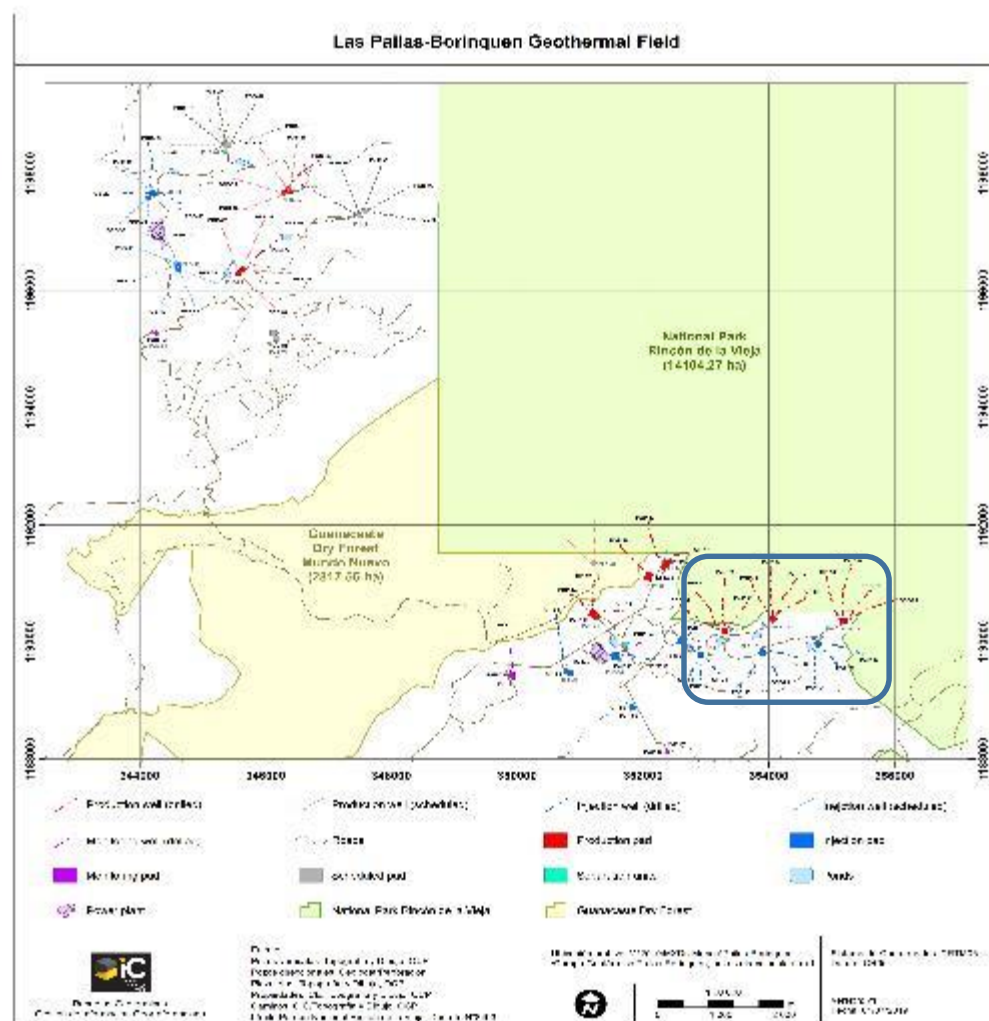
Pailas Geothermal Field. Unit I

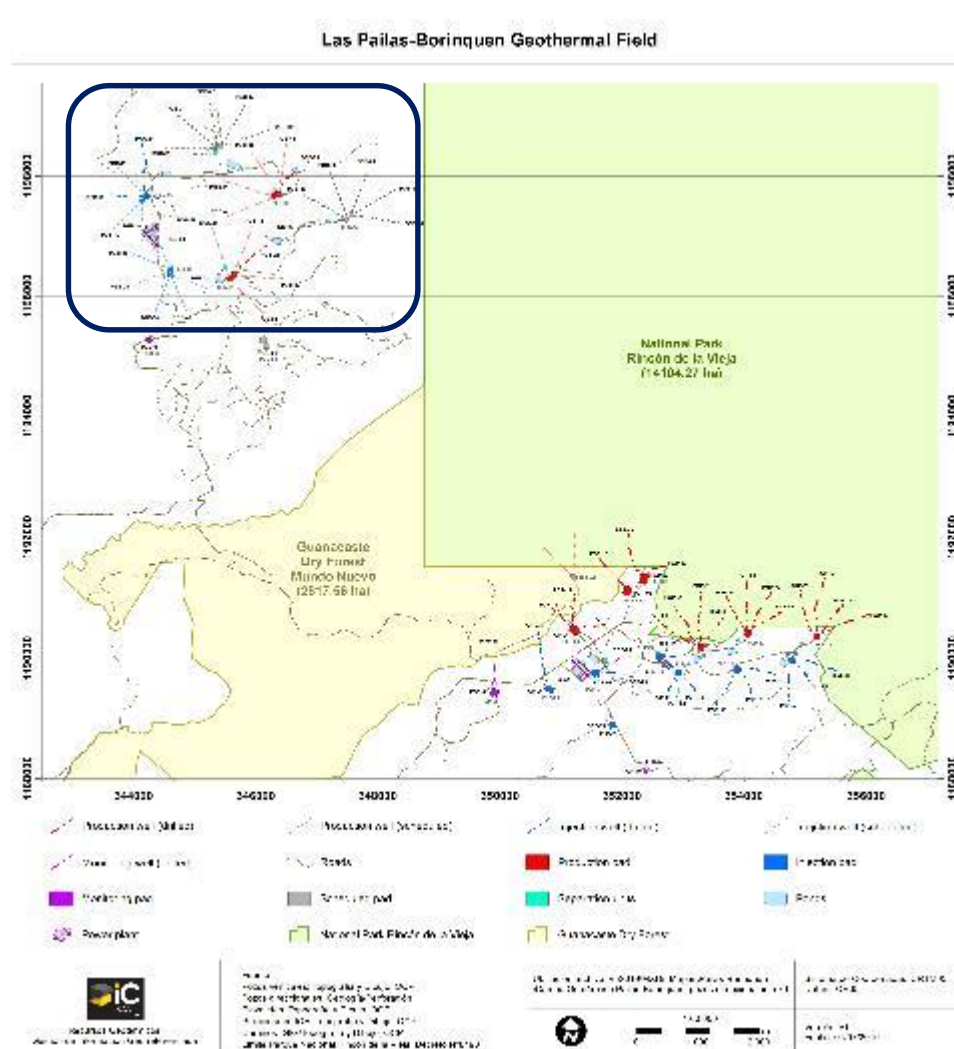
- Star-up operations in 2011
- 42,5 MW installed
- Total pipeline length: 13.86 km (including sewerage system)
- Pressure pipeline: 7.77 km
- 20 wells



Pailas Geothermal Field. Unit II

- Start-up operations in 2019
- 55 MW Installed
- Total pipeline length: 13.88 km (including sewerage system)
- Pressure pipeline: 8.63 km
- 21 directional drilling Wells





Borinquen Geothermal Field. Unit I, Unit II

Conceptual developments under integrated variables:

- Analysis and interpretation of geoscientific information, focused on the reality of the current industrial context.
- Operational flexibility and modular growth.
- Long-term exploitation criteria.
- Scale economy.
- Reality of geographical context.
- Environmental and Social factors.

Borinquen I
55 MW

Start-up 2026

Prepressure pipeline: 11.36 km

Borinquen II
55 MW

Start-up 2030

Prepressure pipeline : 9.51 km

6. Geothermal Resources. Project portfolio

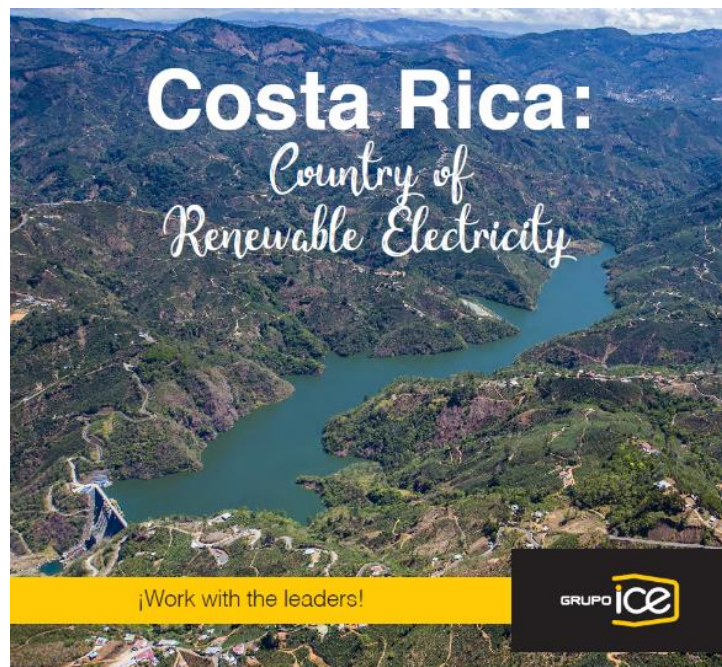
Installed capacity operating and estimated until 2040, in different phases: **538 MW**

	Projet	Locati3n	Capacity MW	Stages	Until	Comments
Exploitation 252 MW	Miravalles etapa I	Volc3n Miravalles, Guanacaste	55	Operaci3n comercial desde 1994	2030	Repotenciado para el periodo 2028-2060 con ajuste de potencia a 35 MW
	UCP- Boca de Pozo	Volc3n Miravalles, Guanacaste	5	Operaci3n comercial desde 1995	2030	Repotenciado para el periodo 2030-2060 potencia a 5 MW
	Miravalles etapa II	Volc3n Miravalles, Guanacaste	55	Operaci3n comercial desde 1998	2030	Repotenciado para el periodo 2030-2060 con ajuste de potencia a 35 MW
	Miravalles etapa III	Volc3n Miravalles, Guanacaste	29,5	Operaci3n comercial desde 2000	2030	Repotenciado para el periodo 2030-2060 potencia 29,5 MW
	Miravalles Etapa V	Volc3n Miravalles, Guanacaste	10	Operaci3n comercial desde 2003	2030	Sistema binario, ciclo de fondo
	Pailas etapa I	Volc3n Rinc3n de la Vieja, Guanacaste	42,5	Operaci3n comercial desde 2011	2036	Pendiente estudios de repotenciamiento
	Pailas etapa II	Volc3n Rinc3n de la Vieja, Guanacaste	55	Operaci3n comercial Junio 2019	2054	Cambio en esquema de desarrollo de yacimientos geot3rmicos. Se introduce la flexibilidad operacional y 100% perforaci3n direccional
Development 110 MW	Borinquen etapa I	Volc3n Rinc3n de la Vieja, Guanacaste	55	Operaci3n comercial 2026	2061	Cuenta con estudio de impacto ambiental, estudio t3cnico y financiamiento
	Borinquen etapa II	Volc3n Rinc3n de la Vieja, Guanacaste	55	Operaci3n comercial 2030	2065	Cuenta con estudio de impacto ambiental, estudio t3cnico y financiamiento
Feasibility 36 MW	PLB-01	Volc3n Rinc3n de la Vieja, Guanacaste	12	Factibilidad avanzada	30 a3os	Disponible para el plan de desarrollo el3ctrico, periodo 2020 - 2030
	PLM-55	Volc3n Miravalles, Guanacaste	12	Factibilidad avanzada	30 a3os	Disponible para el plan de desarrollo el3ctrico, periodo 2020 - 2030
	PLM-54	Volc3n Miravalles, Guanacaste	12	Factibilidad	30 a3os	Disponible para el plan de desarrollo el3ctrico, periodo 2020 - 2030
Reconnaissance 140 MW	RV Norte	Volc3n Rinc3n de la Vieja, Guanacaste	35	Reconocimiento	35 a3os	Proyectado para el plan de desarrollo el3ctrico, periodo 2030 - 2040
	Oros3	Sector Oros3 - Cacao, Guanacaste	35	Reconocimiento	35 a3os	Proyectado para el plan de desarrollo el3ctrico, periodo 2030 - 2040
	Poco Sol	Sector Arenal - Poco Sol, Alajuela	35	Reconocimiento	35 a3os	Proyectado para el plan de desarrollo el3ctrico, periodo 2030 - 2040
	Iraz3	Sector Iraz3-Turrialba, Cartago	35	Reconocimiento	35 a3os	Proyectado para el plan de desarrollo el3ctrico, periodo 2030 - 2040

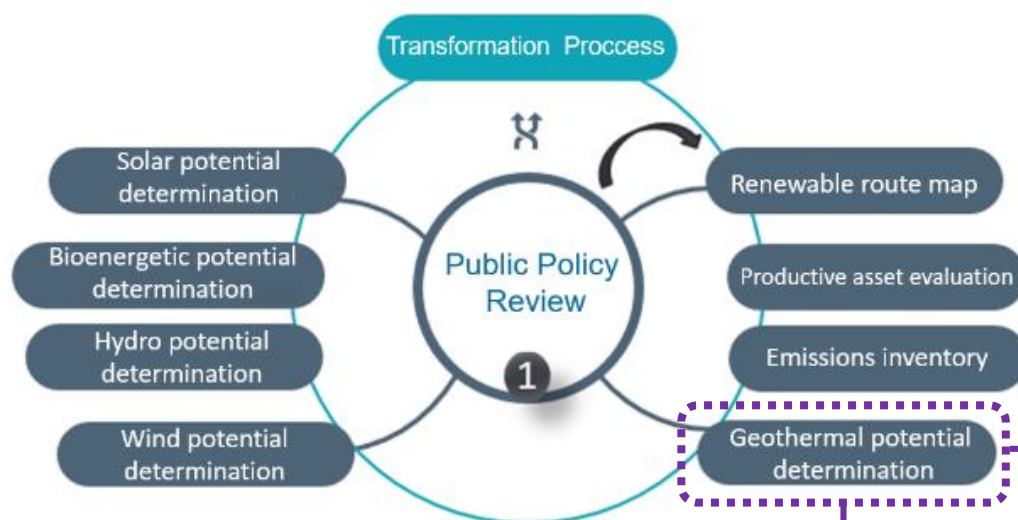


7. Geothermal Services

Service Transformation to a renewable matrix



Transformation from Electric to Renewable Matrix.
Comprehensive and Reliable Solutions for the decarbonization of the matrix



ICE exploration capacity, in drilling services and other geothermal specialties.

Evaluation of Geothermal Potential:

- ICE has proven experience in the study, planning and development of geothermal projects (specialization in all phases of research and development of projects of this type).
- ICE is the interdisciplinary interaction of a range of technical professionals in the areas of engineering, energy, environment, social and economics, which allows the development of integrated studies that analyze the viability and sustainability of the electrical matrix.
- Generation of evaluation report of the Geothermal potential of the country and roadmap for the insertion of the source of energy into the national electricity system is included.

Geothermal: ICE pioneer

- The heat from beneath the Earth's surface -close to the volcanoes in the country- is the second source in participation on the national electric matrix. Costa Rica has researched and exploited it for almost 40 years. Today, Costa Rica exports its knowledge.



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