Global Geothermal Development Plan Roundtable
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Geothermal Energy in Chile

Gobierno de Chile

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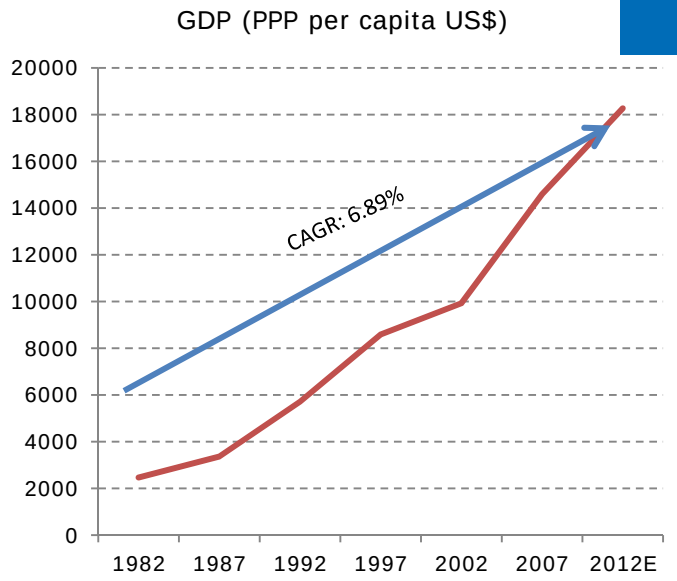
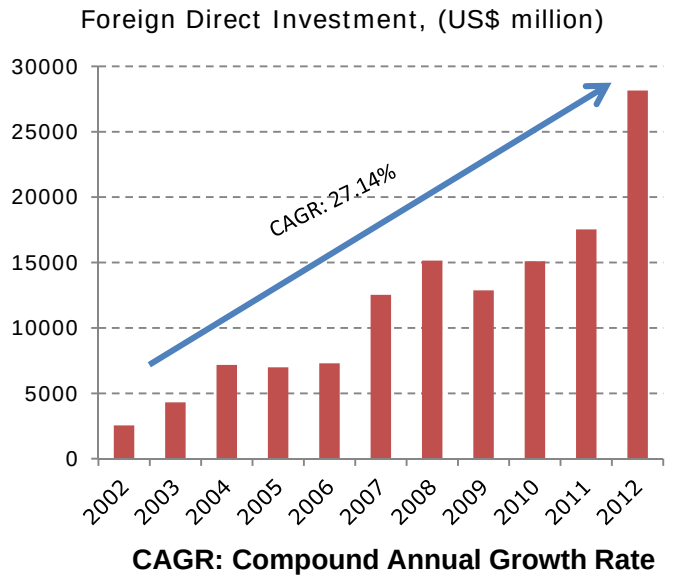
Chilean Energy Sector
Macroeconomic Overview

- Last 30 years, the Chilean economy has had exceptional performances, and became a member of the OECD in 2010.
- Up to 2013, Chile has signed free trade and tax agreements with over 60 and 25 countries, respectively.
- Poverty was reduced from 50% in 1975 to 11% in 2012.
- Public debt was controlled and systematically reduced.
- In October 2012, the Chilean government issued US$ 1,500 million of debt in bonds at the best conditions an emerging economy has ever achieved:
  - 10 year bond was issued at a record 2.38% annual rate.
  - 30 year bond was issued at 3.71% annual rate.





CAGR: Compound Annual Growth Rate

(1) World Bank; (2) United Nations Economic Commission for Latin America; (3) Chilean Ministry Of Finance; (4) Chilean Central Bank

Chilean Energy Sector

Energy Policy

- The basic principles of the present energy policy were defined in Chile in the early eighties.
- Objective: meeting energy demand at the least cost through the operation of competitive (private) energy markets, with a subsidiary role of the State.
- The concepts of diversification and reliability of supply were fostered in 2005 following the natural gas supply curtailments that Argentina started to apply in 2004.

Electricity Market

Generation

- No regulated prices
- Market competition
- Energy traders
- Economic optimum
- Centralized dispatch
- PPAs

Transmission

- Regulated prices
- Natural monopoly
- Open Access
- Expansion through bidding processes

Distribution

- Regulated prices
- Natural monopoly
- Open Access
- Control and standards

Chilean Electric System

Northern Interconnected System (SING)

Installed Capacity: 3.8 GW
Peak Demand (2012): 2.2 GW
100% Thermal:
- 49% Coal
- 42% natural gas
- 9% Oil

Demand: 85% Mining Industry

Central Interconnected System (SIC)

Installed Capacity: 13.5 GW
Peak Demand (2012): 7.2 GW
- 53% Thermal
- 42% Hydro
- 5% Renewable

74% of the national demand
92% of population
76% of PIB

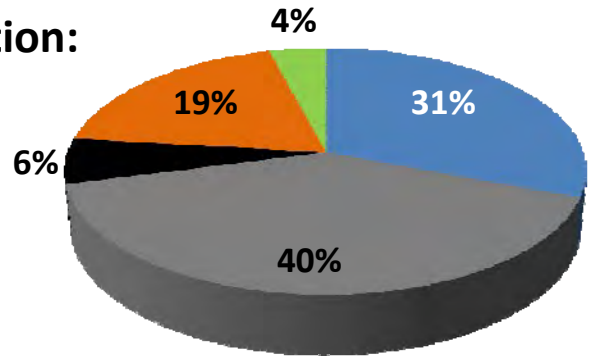
Aysén
-Installed Capacity 50 MW

Magallanes
-Installed Capacity 100 MW

Electricity generation by fuel - 2012

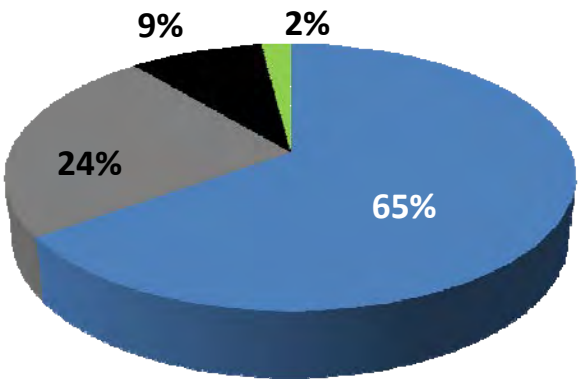
Electricty production:

65.6 TWh

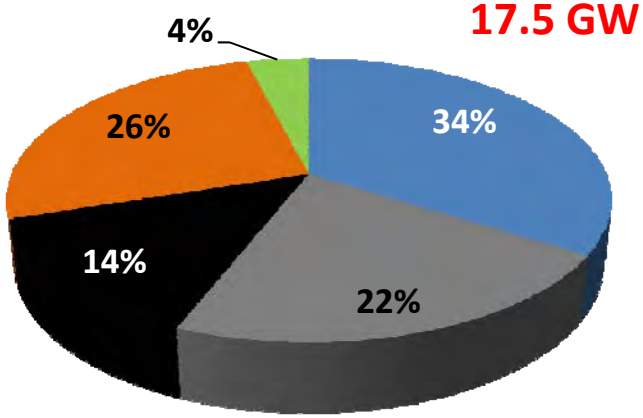


Installed capacity

1996:
6 GW



2012:
17.5 GW



Hydro (>20MW) Coal Oil Natural Gas Renewables

Renewable Energy Opportunities

Chile possesses a unique combination of quality and diversity in its renewable energy potential:

- The Atacama desert receives more annual solar radiation than any other place on earth with a clearest sky.
- Chile has excellent areas for wind energy development.
- Chile is located in a region of the world that has intense seismic and volcanic activity known as the “ring of fire”.
- Chile’s coast stretches 2,653 miles along the pacific, making it a prime candidate for marine energy.
- Chile has the potential to develop large amount of small hydropower from the central to southern regions.
- Rich in bioenergy waste from farming and forestry.

Renewable Energy Potential

Resource	Gross Potential (GW)
Small hydro	23
Bioenergy	10
Wind	40
Geothermal	16
Solar	228
Marine	164
Total	**481**

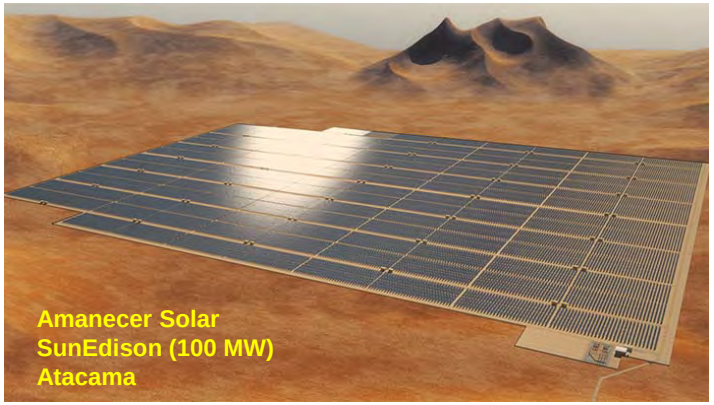
Source: CER

Renewable Energy Today
Main data

Installed Capacity aggregate per year (MW)						
Technology	**Accum. up to 2010**	**2011**	**2012**	**2013**	**2011-2013**	**Total**
Biomass	195	53	144	51	247	442
Wind	170	34		97	132	302
Small hydro	226	31	19	47	97	323
Solar			3	3	6	6
Total	**591**	**118**	**166**	**198**	**481**	**1,072**

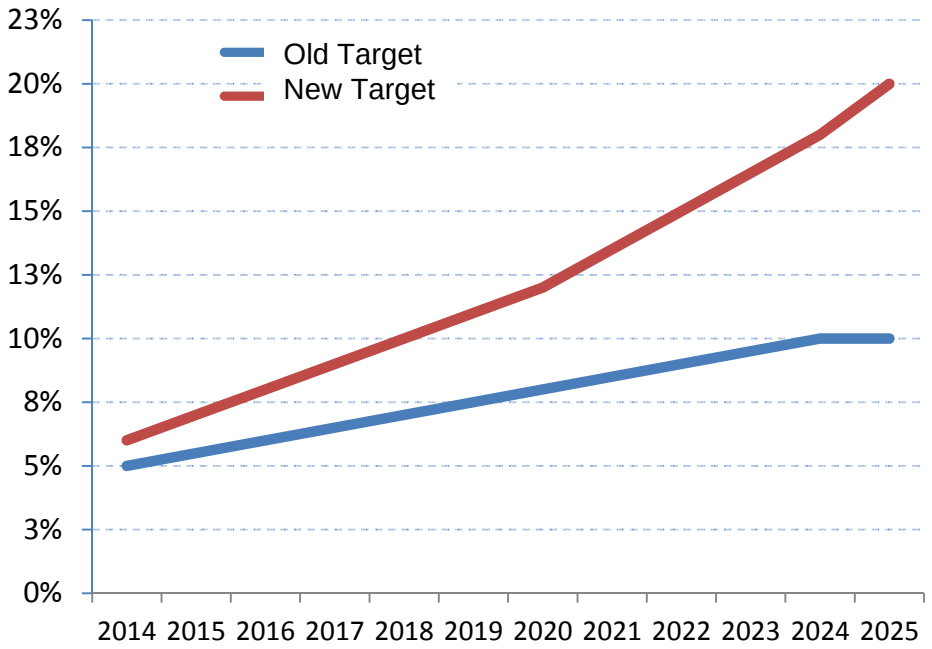

Wind power plant Talinay 90 MW, ENEL Green Power Coquimbo area

Technology	**Operation (MW)**	**Under construction (MW)**	**Environment assessment approved (MW)**	**Under environment assessment (MW)**
Biomass	442	10	106	26
Wind power	302	490	3,585	1,537
Mini-Hydro	323	76	268	139
Solar	5,7	175	4,860	2,052
Geothermal			120	
Total	**1,072**	**751**	**8,939**	**3,754**


Amanecer Solar
SunEdison (100 MW)
Atacama

Source: CER (sep 2013)

New Renewable target Law 20.698, 2013



- In 2008, Chile promoted the increase of renewable energy share in the energy market through a renewable portfolio standard, to reach 10% by 2024.
- This law excludes hydropower plants larger than 20 MW.
- Recently, in October 2013, the new Law N°20.698, requires that 20% of the energy of new energy contracts comes from non-conventional renewable energy (NCRE) sources by 2025.
- In addition, the law creates a new bidding mechanism for new renewable energy projects, where they can get a stable price for 10 years according to the offer made, with a price cap.
- **The new law will require by 2025, approximately 22,700 GWh roughly equivalent to 6,500 MW of renewable projects.**

Geothermal energy in Chile

- Chile is one of the largest under-developed geothermal countries in the world.
- The geothermal systems in Chile are associated with volcanos.
- Over 15 percent of the world's active and dormant volcanoes are in Chile, forming an almost continuous line about 4,000 km long. As a result, over 300 geothermal areas have been identified throughout the country.
- The geothermal-resource potential of Chile may reach 16,000 MWe, according to preliminary estimates.




Geothermal energy in Chile - Regulation

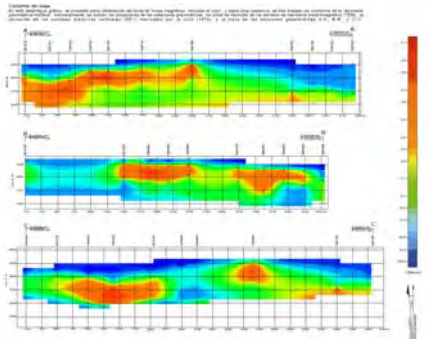
- Law No. 19,657 on Geothermal Energy Concessions, published on January, 2000; governs the granting of permits or concessions, by the government to geothermal developers.

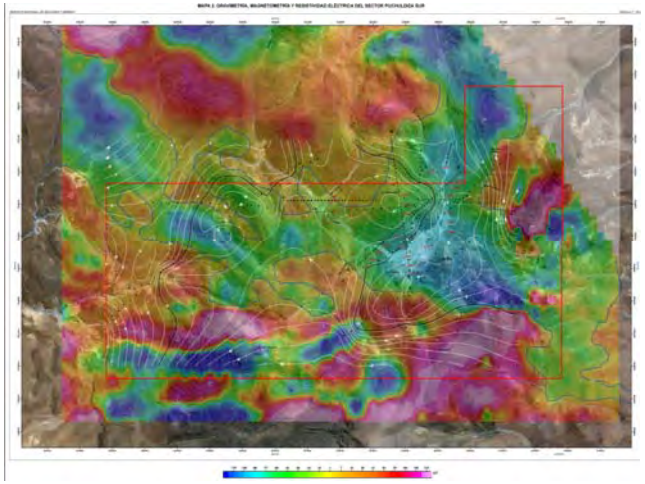
- Rules of procedure for the implementation of Law, contained in Decree N° 32 – 2004 (by-law).

- In March 2013, a new regulation was approved (Decree N°114 - 2013), to streamline the concession process for geothermal projects and provide developers with long-term certainty over development rights.

Geothermal energy concessions

1. **Exploration:** Gives the developer the right to carry out exploratory work to determine geothermal potential.
   - Duration: 2 years extendable for 2 more.
   - Maximum area: 100,000 ha.





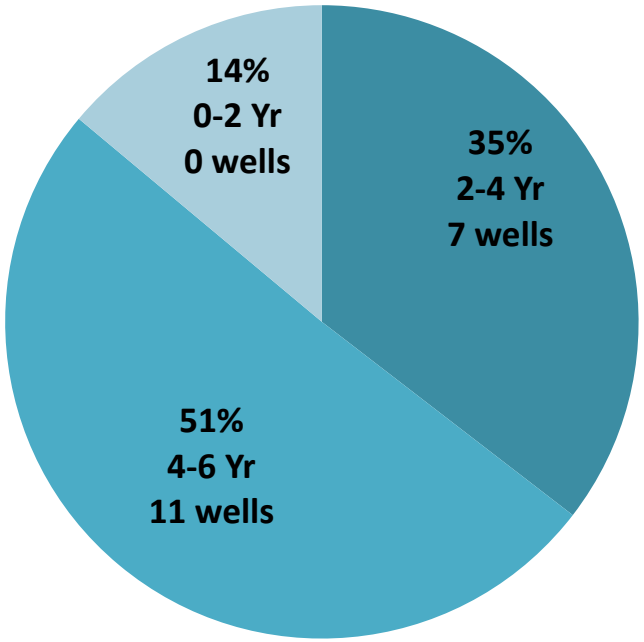
2. **Exploitation:** Awards the developer the right to carry out all the activities required for a geothermal energy generation plant, including drilling, construction, commisioning and operation of an extraction system; the production and processing of geothermal fluids in electrical or thermal energy.

   It confers the right to utilise the geothermal energy that exists within its boundaries.
   - Duration: indefinite.
   - Maximum area: 20,000 ha.

Geothermal energy concessions

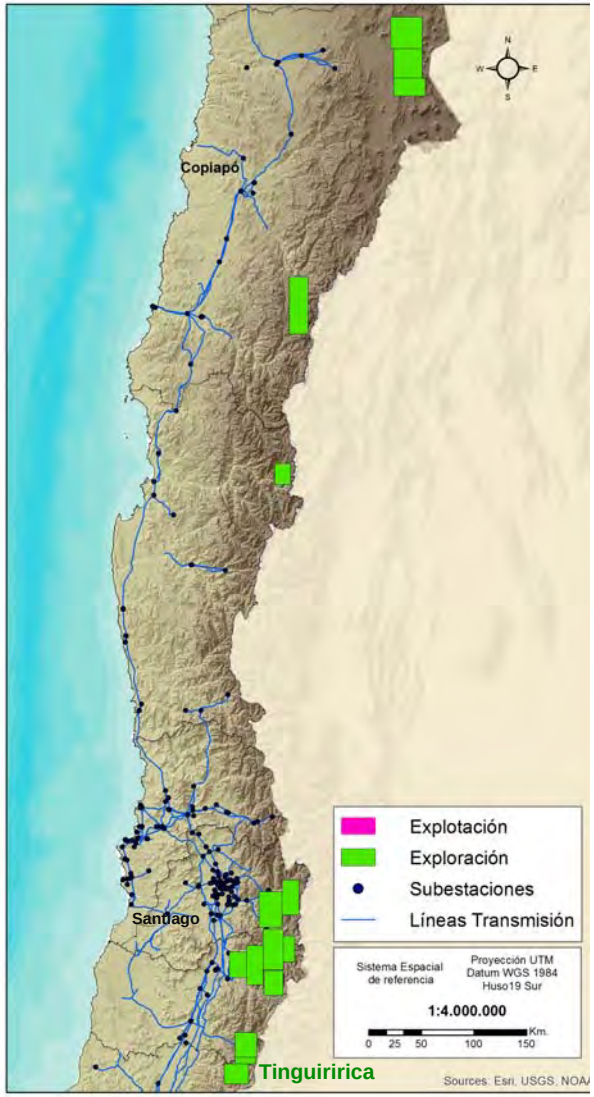
Status	Quantity	Hectares	Commitment US$
Exploration Concessions	79	3 million	380 million
Exploitation Concessions	7	38.000	1160 million

EXPLORATION CONCESSIONS
Lifetime & Exploration wells drilled

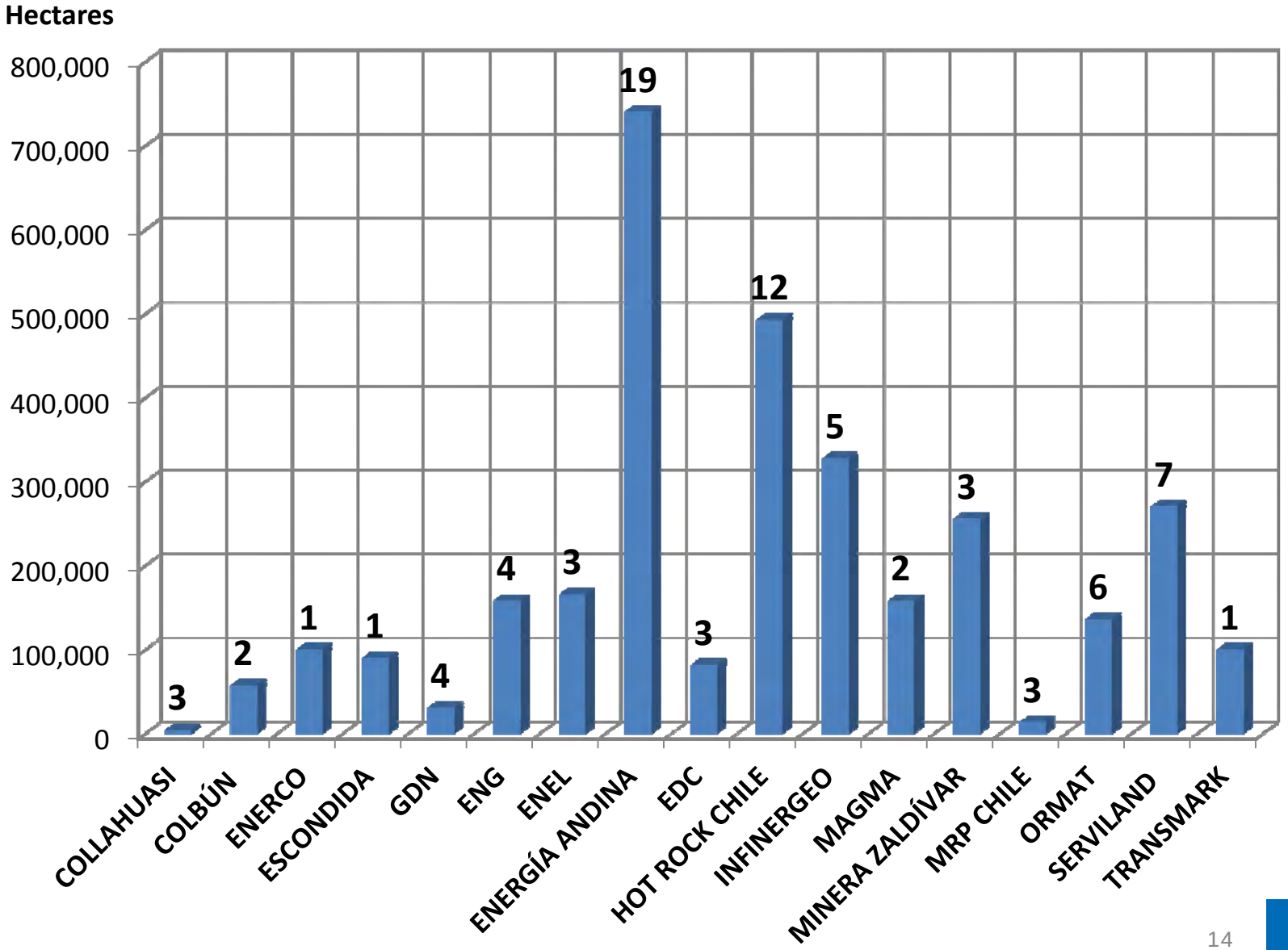


Geothermal concessions by area

3 million hectares in exploration stage



Geothermal exploration concessions by company



Geothermal main projects

Cerro Pabellón (Apacheta concession), ENEL GP

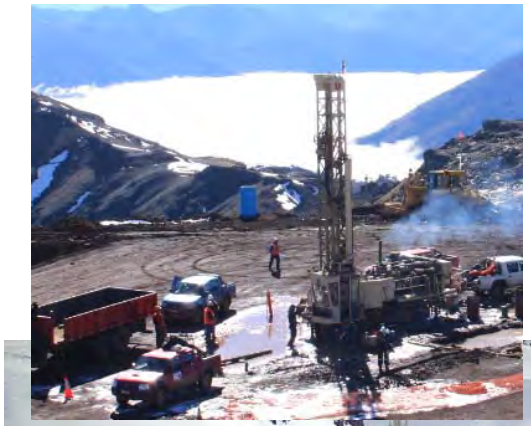
- Environmental approval.
- 2 production wells (1800m, 245° C) + 2 injected wells + 1 slim hole (700m, 210° C)
- Estimated capacity: 50 MW (2018)

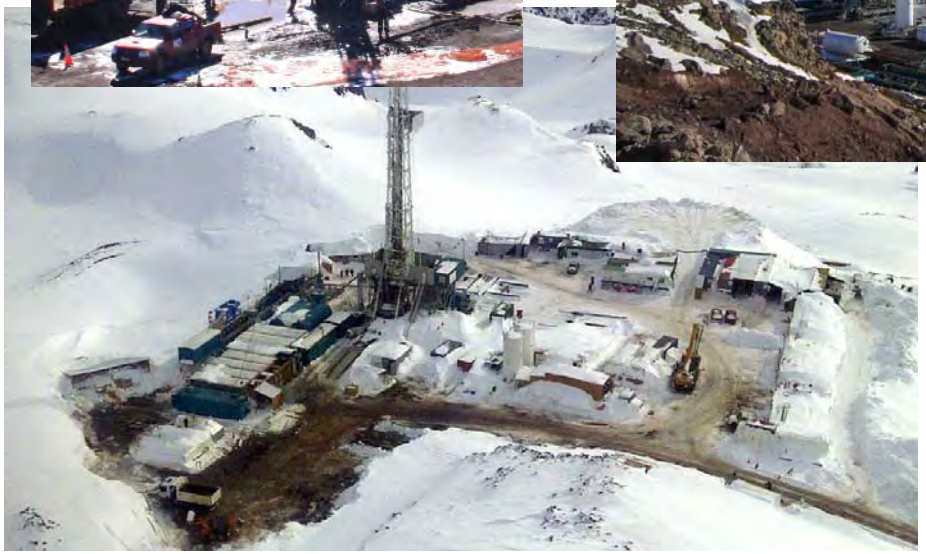
Source: Enel Green Power

Geothermal main projects

Curacautín (San Gregorio concession), MRP Chile

- Environmental approval.
- 2 production wells drilled (2500m, 290° C) + 4 slim hole (1100m, 300° C).
- Estimated capacity: 70 MW (2018)





Source: Mighty River Power

Geothermal main projects

Energia Andina (Origin Energy + Antofagasta Minerals)

Drilling Exploration	
1) Tinguiririca	1 Gradient 813 m core slim Hole (240 °C steam)
2) Pampa Lirima	4 Gradient conventional slim holes 300 m 1 Core Slim Hole 1,500 m
3) Colpitas	1 conventional slim hole 1,007 m
4) Juncalito	Drilling conventional slim hole
5) Puntas Negras	Drilling conventional slim hole

Source: Energía Andina

International Financing and Cooperation

Clean Technology Fund – Geothermal Risk Mitigation Program (MiRiG)
(https://www.climateinvestmentfunds.org/cifnet/country/chile)

Table 5: Chile Revised CTF Financing Plan (2013) (USD million)

Financing source	Component I (CSPP)	Component II (LSPVP)	Component III (RESSEE)	Component IV (RESSEE Prep Grant)	Component V (MiRiG)	TOTAL
CTF loans and grants	67	50	49	1	33	200
GoC	20	0	20	0	14.5	54.5
IDB loans	125	50	50	0	50	275
IDB's Canadian Fund loan	30	0	0	0	0	30
IBRD grants	0	0	0	0	0.5	0.5
IDB grants	1	0	0	0	0	1
GEF	0	0.6	2.8	0	0	3.4
IFC loans	0	50	50	0	0	100
Bilaterals (KfW & LAIF)	148.6	295	0	0	0	443.6
Other private sector	109.4	274.4	250	0	200	833.8
TOTAL	**501**	**720**	**421.8**	**1**	**298**	**1,941.8**

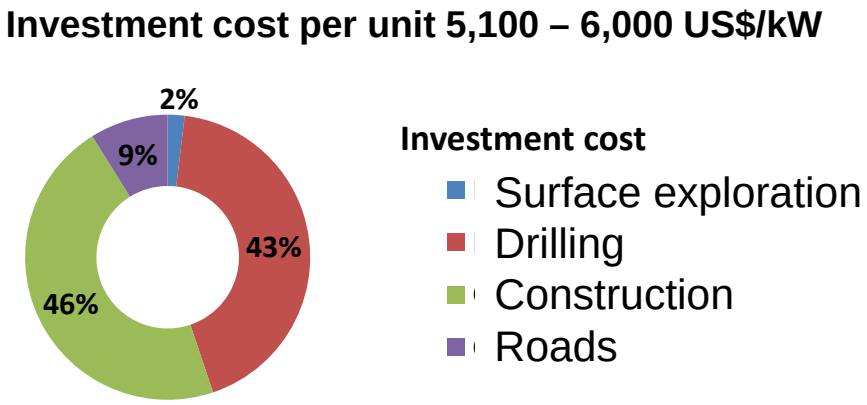
Co-financing figures to be revised at the time of program design

Geothermal Challenges in Chile

- The high altitudes and arid environment of the north create logistical dificulties for the location of camps and the extraction of industrial sites.

- On the other extreme, the glacial morphology of the south complicates access and there is also a limited window of time when work can be carried out.

- High exploration cost, in Chile these costs become even more expensive given the absence –at this moment- of a consolidated geothermal industry.



Geothermal Challenges in Chile

- Companies need to find big resources that can justify long transmission lines.
- Access to the electricty markets (PPAs).
- Geothermal risk mitigation instruments.
- Geothermal security regulations for drilling.
  - Technical colaboration from countries and institutions with the experience.
- Capacity building and communications on geothermal energy.
  - To the community.
  - To the public services involved in the environmental evaluation.

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