Consejo Nacional de Energía

# *Geothermal Energy in El Salvador*


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*Executive Secretary*


**Tokyo, Japan**
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# General Information of El Salvador

- *Location*: Central America, between Guatemala and Honduras bordering with the North Pacific Ocean.
- *Territorial Extension:* 20,742 km$^2$ (approx.)
- *Population:* 6.1 million; Population Density of 294 h/km$^2$

**Compared to El Salvador:**

**Mexico**

Land: 94 times larger

Population: 19 times higher

**Costa Rica**

Land: 2.5 times larger

Population: 0.8 times lower

**Mongolia**

Land: 75 times larger

Population: 0.5 times lower

**Taiwan**

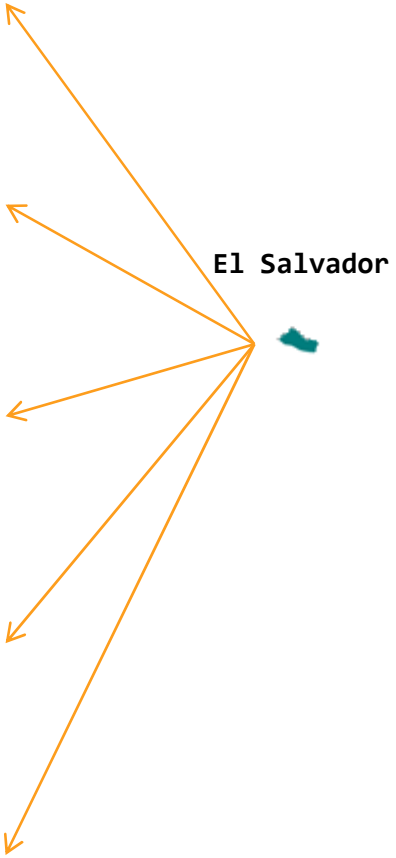
Land: 1.6 times larger

Population: 3.8 times higher

**Japan**

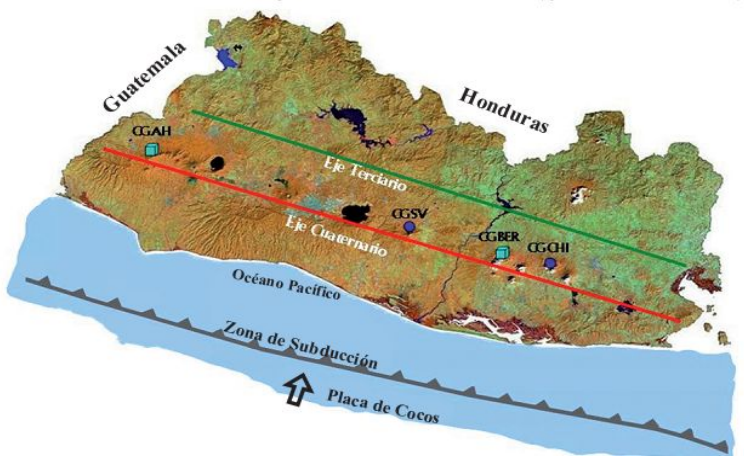
Land: 18 times larger

Population: 21 times higher



# General Information of El Salvador

- El Salvador lies on the Caribbean Plate and is part of the so-called Ring of Fire and the Central American volcanic belt.
- The tectonic of El Salvador is intense and produces a strong seismic activity.
- In El Salvador, are distinguished the following geothermal axis:
  - Quaternary volcanic axis (red line) has temperatures above 150 ° C
  - The third axis (green line) systems from 90 to 150 ° C.
- The geothermal fields under exploitation are located on the red axis.

# Geothermal Development in El Salvador

- **1958** Initial studies of geothermal exploration. As a result, were identified several promising areas to start test drilling to verify geothermal resources.
- After the studies, it was decided to start the first Deep Exploration in Ahuachapán
- **1968** was drilled the first deep well in (AH-1)
- **1975** began operation the first Condensation Generation Unit in Ahuachapán (30 MWe), this with financial support from the World Bank.
- **1976** Began operation the Unit II in Ahuachapán (30 MWe)

German geologist Dr. Fritz Durr
1957

Thermal Waterfall in Ahuachapán

# Geothermal Development in El Salvador

- **1981** Began operation the Unit III in Ahuachapán (35 MWe) reaching a total power generation capacity of 95MWe for the Geothermal Plant of Ahuachapán.
- Due to the socio-political status of the country in the 80s, the geothermal field of Ahuachapán suffered an inadequate management and exploitation that caused a pressure drop in the reservoir. For this reason, recovery activities for this field were implemented.
- **1992**, Began the production of the Geothermal Field in Berlín with two wellhead generation units of 5 MWe each.

Steam stream from well AH-1 in Ahuachapán

Planta geotérmica se instala en Ahuachapán

*Eligen directiva por mejoras de La Paz este día*

Ahuachapán se convertirá en el centro eléctrico más importante de El Salvador —declaró ayer fuente oficial—, al realizarse el proyecto de aprovechamiento de la energía geotérmica de los suelos, cuya fase definitiva está iniciando el gobierno de la República por medio de la Comisión Ejecutiva Hidroeléctrica del Río

# Geothermal Development in El Salvador

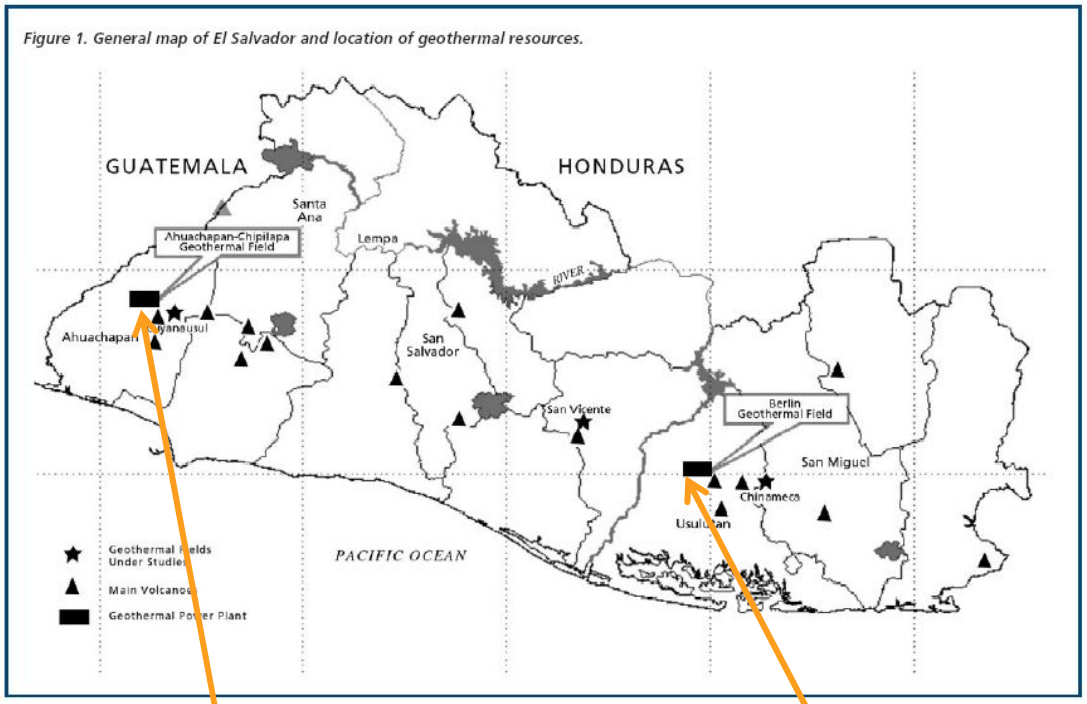
- **1999** began the commercial operation of the geothermal field in Berlín, there were drilled 16 new wells and it was build a new Plant with 2 generation units of 28 MWe each (56 MWe in total)
- **2003–2008**, Ahuachapan's Optimization Project, drilling of two production wells and one for reinjection.
- **2002–2004** full reinjection in Ahuachapán
- **2005–2008** full reinjection in Berlín.
- **2007** began operation the Unit III in Berlín (44 MWe)
- **2007–2008**, began operation the Unit IV (Binary Cycle) in Berlin (9.4 MWe)

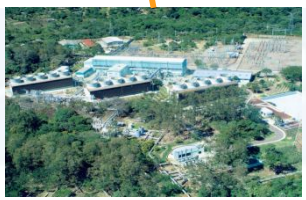
Pipeline in Ahuachapán

Construction of Berlin's field

# Current Status

- In El Salvador there are two high-temperature geothermal fields under concession to LaGeo that are being exploited for power generation (Ahuachapán and Berlin) with a total nominal installed capacity of 204.4 MWe
- Estimations project that Ahuachapán and Berlin geothermal fields ensures between 25 to 30 additional years of production.
- LaGeo has the concession of two more geothermal fields of high temperature, San Vicente and Chinameca.



Generation Plant in Ahuachapán

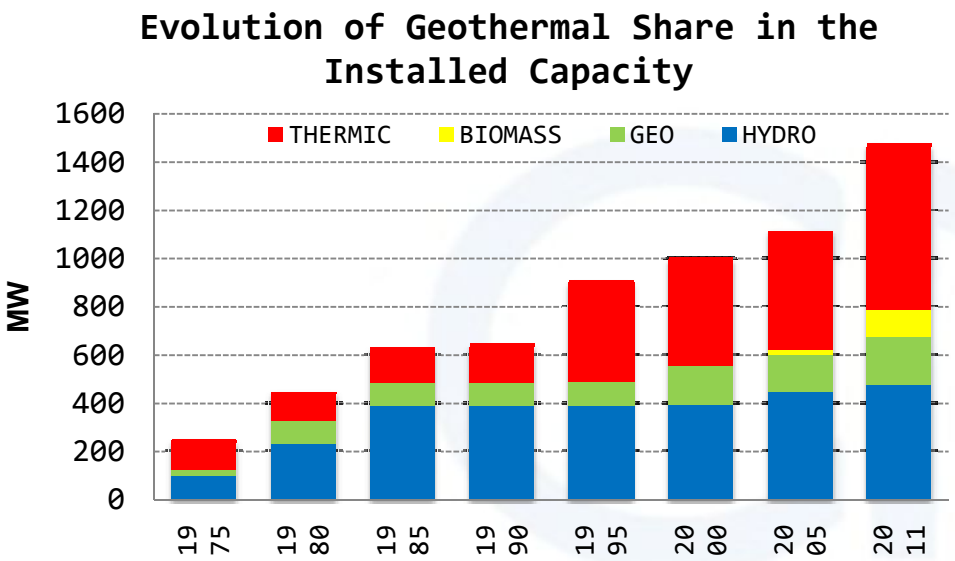
Generation Plant in Berlín

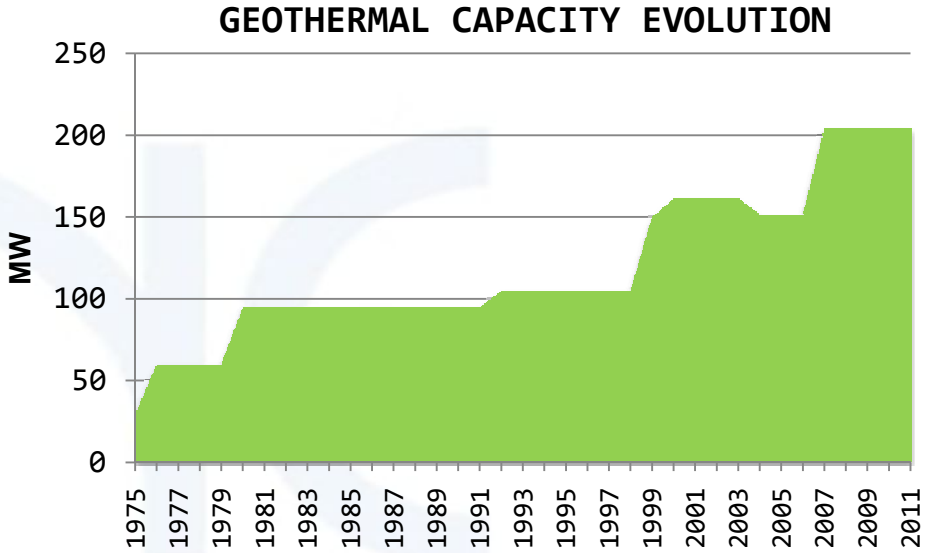
# Current Status

| Details of Ahuachapan's Field | |
|---|---|
| Installed Capacity: | 95 MWe |
| Turbines: | 2 of one Flashing at mid pressure (30 MWe c/u) and 1 of double Flashing at low pressure (35 MWe) |
| Wells Drilled: | 52 (depths from 591 a 1645 meters) |
| Production Wells: | 14 vertical y 6 directional |
| Reinjection Wells: | 9 |
| Monitoring Wells: | 18 |

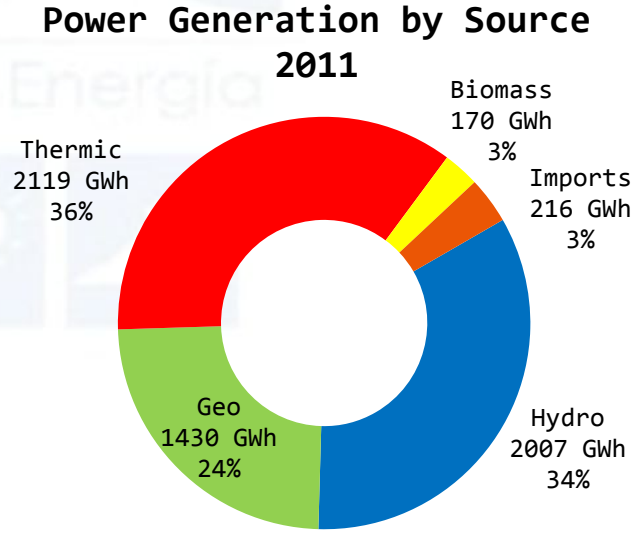
| Details of Berlin's Field | |
|---|---|
| Installed Capacity: | 109.4 MWe |
| Turbines: | 3 of one Flashing at mid pressure (28.1, 28.1 y 44 MWe) and 1 of Binary Cicle (9.2 MWe) |
| Wells Drilled: | 34 (depths from 504 a 3455 meters) |
| Production Wells: | 14 (6 vertical y 8 directional) |
| Reinjection Wells: | 18 |
| Monitoring Wells: | 2 |

# Current Status




| Evolution of Geothermal Share in the Installed Capacity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **1975** | **1980** | **1985** | **1990** | **1995** | **2000** | **2005** | **2011** |
| **% Hydro** | 38.6 | 51.4 | 61.4 | 59.7 | 42.7 | 39.2 | 40.1 | 32.0 |
| **% Geo** | **12.0** | **21.1** | **15.0** | **14.6** | **11.6** | **16.0** | **13.5** | **13.8** |
| **% Biomass** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 7.4 |
| **% Thermic** | 49.4 | 27.5 | 23.6 | 25.7 | 45.7 | 44.8 | 44.2 | 46.8 |



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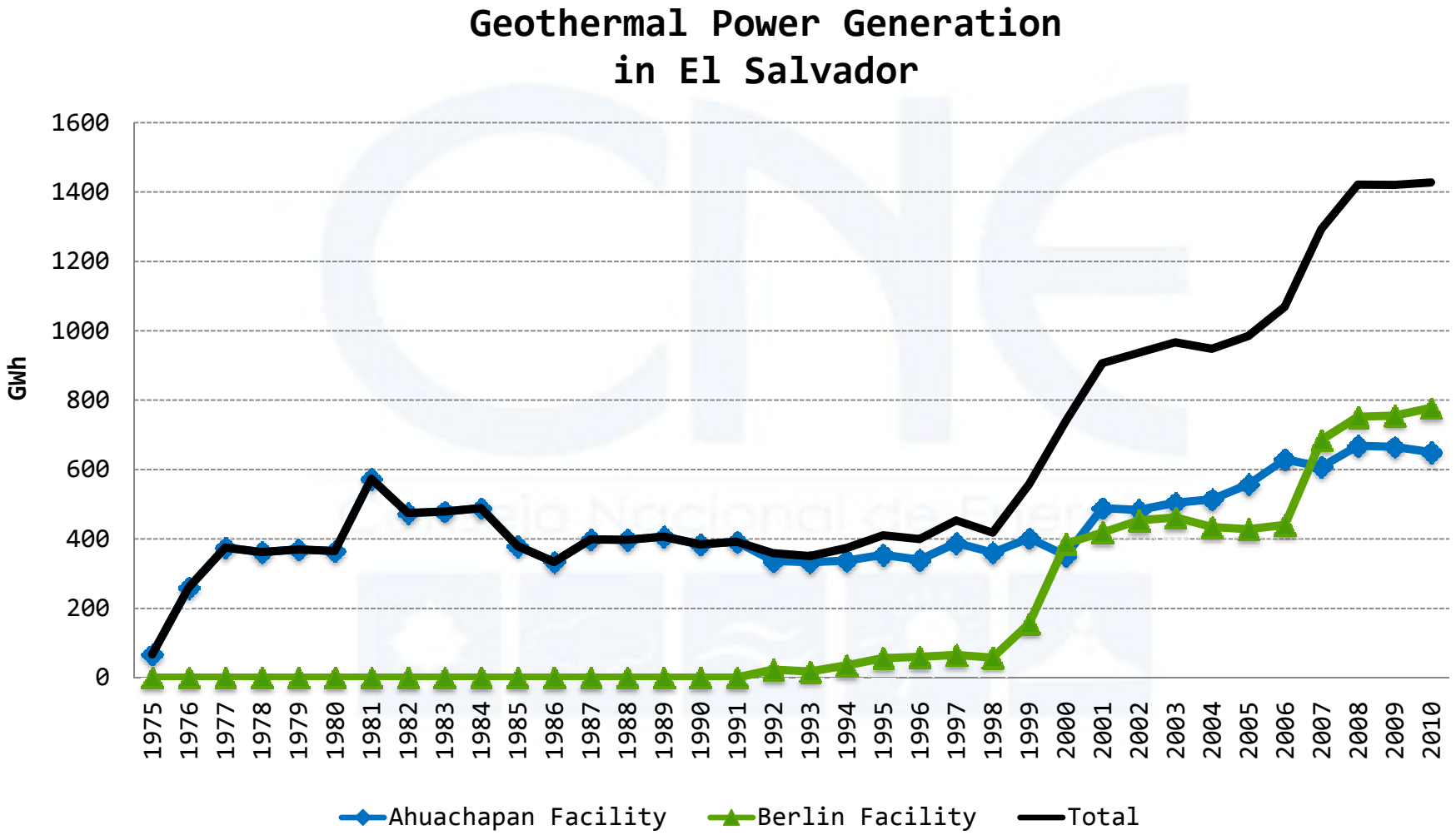

# Current Status

| COUNTRY | INSTALLED CAPACITY (MW) | RANK |
|---|---|---|
| USA | 3,093 | 1 |
| PHILIPPINES | 1,904 | 2 |
| INDONESIA | 1,197 | 3 |
| MEXICO | 958 | 4 |
| ITALY | 843 | 5 |
| NEW ZEALAND | 628 | 6 |
| ICELAND | 575 | 7 |
| JAPAN | 536 | 8 |
| El SALVADOR | 204 | 9 |
| KENYA | 167 | 10 |
| COSTA RICA | 166 | 11 |
| NICARAGUA | 88 | 12 |
| RUSSIA | 82 | 13 |
| TURKEY | 82 | 14 |
| GUINEA | 56 | 15 |
| GUATEMALA | 52 | 16 |
| PORTUGAL | 29 | 17 |
| CHINA | 24 | 18 |
| FRANCE | 16 | 19 |
| ETHIOPIA | 7.3 | 20 |
| GERMANY | 6.6 | 21 |
| AUSTRIA | 1.4 | 22 |
| AUSTRALIA | 1.1 | 23 |
| THAILAND | 0.3 | 24 |

It represents **25.5%** of the national electricity generation

| COUNTRY | POWER GENERATION (GWh) | RANK |
|---|---|---|
| USA | 16,603 | 1 |
| PHILIPPINES | 10,311 | 2 |
| INDONESIA | 9,600 | 3 |
| MEXICO | 7,047 | 4 |
| ITALY | 5,520 | 5 |
| ICELAND | 4,597 | 6 |
| NEW ZEALAND | 4,055 | 7 |
| JAPAN | 3,064 | 8 |
| KENYA | 1,430 | 9 |
| El SALVADOR | 1,422 | 10 |
| COSTA RICA | 1,131 | 11 |
| TURKEY | 490 | 12 |
| GUINEA | 450 | 13 |
| RUSSIA | 441 | 14 |
| NICARAGUA | 310 | 15 |
| GUATEMALA | 289 | 16 |
| PORTUGAL | 175 | 17 |
| CHINA | 150 | 18 |
| FRANCE | 95 | 19 |
| GERMANY | 50 | 20 |
| ETHIOPIA | 10 | 21 |
| AUSTRIA | 3.8 | 22 |
| THAILAND | 2.0 | 23 |
| AUSTRALIA | 0.5 | 24 |

Source:"Geothermal Power Generation in the World". Ruggero Bertani. Enel Green Power

# Future Perspectives of Geothermal Development

- **At professional training level:**

  The Government of El Salvador, through the CNE is running the *Regional Geothermal Training Programme*

  It is financed by the IDB and the NDF and aims to train in the area of geothermal energy, between 2013 and 2015, 60 professionals in total, 30 Salvadorans professionals and 30 from the rest of Latin America and the Caribbean. To undertake this training there will be provided 60 scholarships in total (10 scholarships per year for professionals in Latin America and the Caribbean and the same number for Salvadoran professionals).

# Future Perspectives of Geothermal Development

- **<u>At the development and commercial exploitation level:</u>**

  1. The semi-private company LaGeo is the only responsible for conducting exploration and exploitation of geothermal resources for power generation using high enthalpy geothermal sources; and will continue their exploitation for this use

  2. The government of El Salvador, through the National Energy Council and with the assistance of the German cooperation Agency, has began the developing process of the low enthalpy geothermal resources for alternative uses of those in the industry, commerce and / or services.

  There will be performed a National Diagnostic to identify the barriers to these projects and is going to be elaborated a roadmap to solve them .

San Miguel

Santa Rosa de Lima

Santa Rosa de Lima

# Bidding Process for 350 MW of Power and it’s Energy

# Bidding of 350 MW

- **What is it?**

  It is an open international tender that seeks to sign a long term contract with the electricity distribution companies to provide 350 MW of power and its related energy.

- **Length of Contract**

  Period of time of 20 years.

- **Who can participate?**

  International and Domestic Companies interested in the power supply to distribution companies in El Salvador.

- **Bidding Guidelines**

  - The supply must be done with new machinery.
  - The technology must be based only on renewable resources, natural gas or coal.
  - There must be a commitment to social development in the areas near the project of electricity generation.
  - Any other requirements established in the bidding conditions (mostly environmental).

# Bidding of 350 MW

- **Charges to be remunerated**
  - Energy: the contract price will be paid according to the offer received.
  - Power: Base price will be approved by the Regulator.
- **Cost of the bidding conditions**
  - US$10,000 + TAX = US$11,300.
- **Information Contact**
  - Ing. David Perla
  - E-mail: licitaciones@delsur.com.sv

- **Bidding Process Stages**

| Bidding | Date |
|---|---|
| Prior publication of bidding | Oct. 23/2012 |
| Sale of Bidding Conditions and registration of participants | Dec. 13/2012 to Apr. 05/2013 |
| Reception of qualification documents and economic offers | Apr. 25/2013 to Jun. 04/2013 |
| Evaluation of economic offers | Jun. 05/2013 |
| Award of the contract | Jun. 25/2013 |
| Contract Signing | Jul. 02/2013 |
| Beginning of Supply | Jul. 01/2017 |

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