Unlocking Sunbelt Countries’ Solar Potential
Chile: a bright present and a great potential

Carlos Finat
Executive Director
Oh sol, cristal paterno, horario y poderío, progenitor planeta, gigante rosa rubia siempre hirviendo de fuego,

Pablo Neruda, Premio Nobel 1971
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- Regulatory overview.
- Estimated CSP potential.
- Status of CSP in Chile – Projects.
- Cerro Dominador solar complex.
- Status of CSP in Chile: Market.
- Policy related matters:
  - Solar Technology Center.
  - Solar Technology District.
Chilean power system

Source: CDECSIC, CDEC-SING and CNE
Date: December 2016

[PURO ENERGÍA]
Facts and figures of Chile’s power sector.

<table>
<thead>
<tr>
<th>Technology</th>
<th>2017 Production (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermoelectric</td>
<td>49094</td>
</tr>
<tr>
<td>Hydroelectric</td>
<td>19463</td>
</tr>
<tr>
<td>Wind</td>
<td>2005</td>
</tr>
<tr>
<td>Solar</td>
<td>2563</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>73125</strong></td>
</tr>
</tbody>
</table>

Distribution of Energy Production 2017 by technology:
- Thermoelectric: 67%
- Hydroelectric: 27%
- Wind: 3%
- Solar: 3%

<table>
<thead>
<tr>
<th>Technology</th>
<th>2017 Production (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioenergy</td>
<td>2525</td>
</tr>
<tr>
<td>Wind</td>
<td>2317</td>
</tr>
<tr>
<td>Hydro</td>
<td>1746</td>
</tr>
<tr>
<td>Solar</td>
<td>2564</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9151</strong></td>
</tr>
</tbody>
</table>

Distribution of NCRE Production 2017 by technology:
- Bioenergy: 28%
- Wind: 28%
- Hydro: 19%
- Solar: 25%
The energy sector regulations are based in the Energy Policy.

Access to the power generation market is open and new generation is developed by private companies, with no central planning.

Objectives of the policy are directed to obtain competitive, secure, sustainable and inclusive power supply.

No subsidies nor feed-in tariffs are available for generation.
## Estimated CSP Potential

CSP potential was estimated mainly by:
- Mapping the radiation level.
- Finding suitable land for power plant of 50 MW or more

### Available Potential

<table>
<thead>
<tr>
<th>Region</th>
<th>CSP (MW)</th>
<th>f.p.</th>
</tr>
</thead>
<tbody>
<tr>
<td>De Arica y Parinacota</td>
<td>6,311</td>
<td>0,51</td>
</tr>
<tr>
<td>De Tarapacá</td>
<td>136,085</td>
<td>0,51</td>
</tr>
<tr>
<td>De Antofagasta</td>
<td>390,476</td>
<td>0,53</td>
</tr>
<tr>
<td>De Atacama</td>
<td>15,607</td>
<td>0,51</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>548,479</strong></td>
<td><strong>0,52</strong></td>
</tr>
</tbody>
</table>
Status of CSP in Chile - Projects

- Projects under environmental qualification

<table>
<thead>
<tr>
<th>Project's Name</th>
<th>Holder</th>
<th>Power (MW)</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planta de Concentración Solar de Potencia Likana Solar</td>
<td>Likana Solar SpA (Solar Reserve)</td>
<td>450</td>
<td>Under qualification</td>
</tr>
<tr>
<td>Planta de Concentración Solar de Potencia Tamarugal Solar</td>
<td>SolarReserve Chile Ltda (Solar Reserve)</td>
<td>450</td>
<td>Under qualification</td>
</tr>
<tr>
<td>FOTOELECTRICIDAD EL LOA</td>
<td>ANDES GREEN ENERGY SPA</td>
<td>300</td>
<td>Under qualification</td>
</tr>
<tr>
<td>Planta Solar Copiapó</td>
<td>Abengoa Solar Chile SpA.</td>
<td>315</td>
<td>Under qualification</td>
</tr>
<tr>
<td>Planta de Concentración Solar de Potencia Copiapó Solar</td>
<td>Copiapó Energía Solar SpA (Solar Reserve)</td>
<td>240</td>
<td>Approved</td>
</tr>
<tr>
<td>Planta Termosolar Maria Elena</td>
<td>Iberéólica Solar Atacama S.A.</td>
<td>400</td>
<td>Approved</td>
</tr>
<tr>
<td>Planta Termosolar Pedro de Valdivia</td>
<td>Iberéólica Solar Atacama S.A.</td>
<td>360</td>
<td>Approved</td>
</tr>
<tr>
<td>Planta Termo Solar para Calentamiento de Soluciones</td>
<td>Minera Centinela</td>
<td>7</td>
<td>Approved</td>
</tr>
</tbody>
</table>

- Projects approved by environmental authority

<table>
<thead>
<tr>
<th>Project's Name</th>
<th>Holder</th>
<th>Power (MW)</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planta Solar CEME1</td>
<td>CEME1 SpA</td>
<td>70</td>
<td>Approved</td>
</tr>
<tr>
<td>Proyecto Planta Termosolar Camarones</td>
<td>ELECNOR Chile S.A.</td>
<td>105</td>
<td>Approved</td>
</tr>
<tr>
<td>Planta Solar Atacama 2 CSP</td>
<td>Abengoa Solar Chile SpA.</td>
<td>110</td>
<td>Approved</td>
</tr>
<tr>
<td>Planta de Concentración Solar de Potencia Copiapó Solar</td>
<td>Copiapó Energía Solar SpA (Solar Reserve)</td>
<td>240</td>
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<td>7</td>
<td>Approved</td>
</tr>
</tbody>
</table>

- Projects under construction

<table>
<thead>
<tr>
<th>Project’s Name</th>
<th>Holder</th>
<th>Power (MW)</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Atacama I) “PLANTA SOLAR CERRO DOMINADOR”</td>
<td>Abengoa Solar Chile S.A</td>
<td>110</td>
<td>Under Construction</td>
</tr>
</tbody>
</table>

[ACERA]

[PURA ENERGÍA]
Cerro Dominador solar complex

- Owned by EIG and being built by Abengoa.
- It comprises a 100 MW photovoltaic plant and a 110 MW solar thermal plant.
- Its thermal storage system gives the solar thermal plant the capacity to generate energy during the 24 hours.
• The project was awarded with blocks of 24 hours in the power tender of 2014.
• The project is in the stage of resumption of works.
• In the first instance, the photovoltaic plant will be completed. It is expected to start operating during 2017.
• Subsequently, the completion of the CSP will continue.
• Total investment of the project is more than 1.000 million dollars
Status of CSP in Chile: Market

• CSP projects have participated in energy tenders for distribution companies:
  – Abengoa (Tender 2015-02)
    • Won a contract for 38,8 GWh/yr at a price of 97 US$/MW/h
    • Weighted average price of the tender was 79,3 US$/MWh
  – Solar Reserve (Tender 2015-01)
    • Offered 67,86 USD/MWh for 8,360 GWh/yr
    • Didn’t win energy blocks
    • Offer was 5,97 US$/MWh, below the average of LNG and coal offers.
    • Weighted average price of the contracts that were awarded was 47,6 US$/MWh
Policy related matters
The main purpose of this project is to strengthen our technology infrastructure and human capital to develop solar technology programs, which will consider the following lines:

### MAIN LINES

<table>
<thead>
<tr>
<th>DESERT PV SYSTEMS</th>
<th>MOLTEN SALTS FOR CSP</th>
<th>SOLAR METALLURGY</th>
<th>FUELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of PV components suited for extreme desert conditions</td>
<td>Use of minerals like Lithium to test new molten salts for CSP technologies</td>
<td>Development of technological applications to intensify the use of solar energy in metallurgy processes</td>
<td>Test of technologies to produce fuels using PV electricity or concentrated solar energy</td>
</tr>
</tbody>
</table>
STC’s main roles

R&D: simulation systems and technology services, development of small-scale prototypes and testing of new materials and technologies

Industry services: product pilot programs, monitoring and certification systems.

Transfer and sale of technology: sale and licensing of technologies and materials.

Creation of spin-offs and design of business models.

Generation of information for the drafting of policies for the development, regulation and strengthening of Chile’s solar power industry.
The DMSTP is one of the Solar Road Map initiatives that brings together the government, and national and international companies and technology centers in a partnership to implement a portfolio of R&D&I projects to develop photovoltaic systems created specifically for desert conditions.
DMSTP OBJECTIVES

- To adapt and/or develop new materials, components and O&M services for photovoltaic systems.

- To ensure their durability and performance under desert climate conditions.

- To contribute to the installation of technological capabilities and to foster the creation of a national business ecosystem for the solar power industry in partnership with international companies.
EXPECTED RESULTS

Development of the Desert Module (DEMO) in 4 versions showing growing efficiency and durability.

Technology baselines for the drafting of standards and the creation of compliance evaluation systems for photovoltaic technologies under desert conditions.

Specialized services for the operation and maintenance of these systems.

Development of BoS technology innovations, including component integration, assembly systems, and power inverters.

Reinforced R&D infrastructure and a team of 20 researchers (engineers, MSc and PhD holders) with research skills and inserted into international innovation networks.
In cooperation with GIZ and DLR a mapping of the selected technologies value chain will be made, a survey of local businesses gaps will be held and a competitive development strategy will be defined.

**COMPONENTS**

**INDUSTRIAL DEVELOPMENT**

In cooperation with GIZ and DLR a mapping of the selected technologies value chain will be made, a survey of local businesses gaps will be held and a competitive development strategy will be defined.

**SITE DEVELOPMENT**

Development of optimal sites based in its technical characteristics, baselines, electric infrastructure, fitting out perimeter closures and interior roads, concession tendering and granting to generators.

**FINANCING**

Financing opportunities through Climate Change Funds.

**ENERGY SUPPLY**

Management with free clients (mining industry) and analysis of opportunities within the next Electrical Bids.

- MEGA SOLAR POWER STATION (750 MW- 1GW)
- TECHNOLOGICAL MIX
- SUPPLY QUALITY (~ 24/7)
STD EXPECTED IMPACTS

TOTAL INVESTMENT

4,000 MM US$

EMPLOYMENT

3,000 direct employment during construction

300 direct employment during operation

~12,000 indirect employment over its life cycle

EMISSIONS REDUCTION

1,000,000 TON CO2 EQ. (REF. COAL)

600,000 TON CO2 EQ. (REF. NG)
CONCEPT
If you want to know more about the Solar programs, please contact

– Rodrigo Mancilla
– Manager – Solar Strategic Program
– rodrigo.mancilla@corfo.cl
– +562 2696 9600
Resources available from ACERA

Web

Newsletter

Mapa de Proyectos

informaciones@acera.cl

@ACERAAG

Asociación Chilena de Energías Renovables, ACERA AG.
¡Gracias!

Carlos Finat D.
Director Ejecutivo ACERA

- Ingeniero Civil Electricista
- Director de Operación y Peajes del CDEC-SING – 1999 – 2008
- Representante de clientes libres en el Directorio del CDEC-SING – 2010 – 2012
- Presidente del CDEC-SING – 2011-2012
- Director Ejecutivo de ACERA desde Octubre de 2012