Solar Thermal Heat for Mining Processes

José M. Cardemil
Mechanical Engineering Department, UChile
Associate Researcher, SERC Chile
Agenda

1. Energy Consumption in Chile
2. Heat Consumption for industrial processes
3. Location of mining facilities
4. Copper Mining Processes
5. Process Integration
6. Plants currently in operation
7. New opportunities
8. Challenges
Energy consumption in Chile

Source: Cochilco, 2016; Ministry of Energy, 2016
## Heat consumption in industrial Processes

### MINING

- Copper
- Various mines

### WOOD

- Paper and cellulose
  - Wood pulp, paper, and cardboard
  - Other articles of paper and cardboard
  - Paper and cardboard containers
  - Sawing and planing

### FOOD

- Meats
- Food products
- Preparing and preservation of...
  - Milling, starches...
  - Animal foods
  - Tobacco
  - Wines
  - Nuts
  - Almonds
  - Olives

### OTHER CATEGORIES

- Glass...
- Metal products
- Chemical...
- Iron and steel industry
- Metallic products for structural use
- Other...
- Fertilizers and nitrogen compounds
- Oil
- Petroleum products
- Other products

### TEXTILE

- Various textile products

### MACHINERY

- Various machinery products

### ELECTRONICS

- Various electronic products

### MINING

- Various mining products

### CHEMICAL PRODUCTS

- Various chemical products

### TRANSPORT

- Various transportation products

### PRECIOUS METALS

- Various precious metals products

### PLASTIC AND RUBBER

- Various plastic and rubber products

### GLASS AND CERAMICS

- Various glass and ceramics products

### OTHERS

- Various other products
Copper Mining Processes

- The production process depends on the raw materials being processed: sulfides, or oxides.

- Both processes used heat in different temperature ranges.
  - **Sulfide** processing is called pyrometallurgy. Two processes where heat is used: smelting copper (>1000 °C), and drying.
  - **Oxide** processing is called hydrometallurgy. Heat is used for the EW process and for Leaching. (45 - 55°C)

Source: European Copper Institute, 2018
Particular Features
Particular features

• Copper Mining facilities are located in areas with
  – High altitude
  – High solar availability

• Chile does not produce significant fossil resources
  – Using diesel has also high transportation costs.
Process Integration
### Centinela Mining Co.

<table>
<thead>
<tr>
<th>Collector</th>
<th>PT-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working fluid</td>
<td>Pressurized water</td>
</tr>
<tr>
<td>Solar field surface (m²)</td>
<td>16,742</td>
</tr>
<tr>
<td>Storage size (m³)</td>
<td>300</td>
</tr>
<tr>
<td>Annual heat production (MWh₉)</td>
<td>24,845</td>
</tr>
<tr>
<td>Solar Fraction</td>
<td>55.60%</td>
</tr>
<tr>
<td>Fuel savings</td>
<td>55%</td>
</tr>
<tr>
<td>CO₂e emission savings (ton)</td>
<td>7,951</td>
</tr>
<tr>
<td>Yearly sum of DNI (MWh)</td>
<td>~53,058</td>
</tr>
</tbody>
</table>

March 10th, 2020
JM Cardemil - SERC Chile
Gaby Mining Company – Pampa Elvira Solar

<table>
<thead>
<tr>
<th>Collector</th>
<th>HT Heat Boost 35-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar field surface (m²)</td>
<td>39,300</td>
</tr>
<tr>
<td>Storage size (m³)</td>
<td>4,300</td>
</tr>
<tr>
<td>Annual heat production (MWhₜₜ)</td>
<td>54,000</td>
</tr>
<tr>
<td>Solar Fraction</td>
<td>55.83%</td>
</tr>
<tr>
<td>Fuel savings</td>
<td>80%</td>
</tr>
<tr>
<td>CO₂e emission savings (ton)</td>
<td>15,000</td>
</tr>
<tr>
<td>Yearly sum of DNI (MWh)</td>
<td>~97,500</td>
</tr>
</tbody>
</table>

Source: [https://ellaimasolar.cl/](https://ellaimasolar.cl/)
New Opportunities

- Leaching

- Solution (PLS) heating

Challenges...

- Water usage
- Soiling
Thanks!!

- More information...


jose.cardemil@uchile.cl