Unleashing Mining’s Full Potential
Tackling Sector Challenges

Large scale innovations & technologies,
creating knowledge intensive industries

Marcos Kulka · Fundación Chile
January 20th, 2015
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Fundación Chile

• Founded in 1976 by ITT Corporation and the State of Chile
• BHP enters the Board of Directors in 2005
• Mission: To increase the Country’s competitiveness through innovation
  Do Tank (+90 companies created; 14 sectors)
• Public mission, private management model
From Salmon to Global Challenges

Sustainability  Food and Biotechnology  Digitalization  Human Capital
FCh at a Glance

- 113 initiatives
- +90% of Chile’s GDP
- +160 international organizations in 35 countries
- Pioneers in the salmon export industry
- 61% of revenue by new initiatives <= 3 years
- +2 billion dollars in social value
- Venture capital
- 39 new initiatives <= 3 years
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Mining Development Opportunity

Chile, world leader in Copper

World Copper Production Participation

Chile represents 1/3 of reserves 1/3 of sales

Source: Consejo Minero Report 2012-2013

“Countries converge to the sophistication degree of their exports.”

- Ricardo Hausmann, Harvard

FISCAL REVENUE

<table>
<thead>
<tr>
<th>1976</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>17%</td>
</tr>
<tr>
<td>Chemical wood pulp, soda or sulphate</td>
<td>4.3%</td>
</tr>
<tr>
<td>Chemicals and fertilizers</td>
<td>3%</td>
</tr>
<tr>
<td>Iron and steel, semifinished products</td>
<td>2%</td>
</tr>
<tr>
<td>Chemical wood pulp, not for humans</td>
<td>0.7%</td>
</tr>
<tr>
<td>Other non-ferrous base metals</td>
<td>0.6%</td>
</tr>
<tr>
<td>Fish</td>
<td>0.1%</td>
</tr>
<tr>
<td>Paper and paperboard</td>
<td>0.1%</td>
</tr>
<tr>
<td>Other non-metallic mineral products</td>
<td>0.1%</td>
</tr>
<tr>
<td>Wood</td>
<td>0.1%</td>
</tr>
<tr>
<td>Other manufactures</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

15 companies
95% of copper’s national production

11.1% GDP
57.3% EXPORTS

10.0% FISCAL REVENUE
11.4% WORKFORCE

*Direct and indirect employment
Potential Copper Growth Scenarios
Leveraging Technology
Building an Industry Roadmap

Copper Mine Production 1900-2013 & Scenarios 2014-2033

Source: USGS, International Copper Study Group; http://www.chilex.com/copper-market/;
Tackling Mining Industry Challenges

Cumulative Efforts

- Cycle closure, positive socio-environmental balance
- Ensure the future (exploration)
- Support investment for growth
- Ensure competitiveness of productive base

Level of accumulated Capacity during period

- Level of Institutional development
- Level of human Capital development
- Level of supplier development
- R&D + Innovation capacity
- Productive capacity

Scenario A

- Copper Production
- Effort Level

Scenario A Cu Production

- Scenario A
- Effort Level

- Low replenishment of deposits
- Energy
- Communities
- Low grade of deposits
- Productivity
- Local supplier capacity
- Low grade of environmental permits
- Duplicity of environmental permits
- 60% of reserves in Central Region
- Low Appreciation for mining
- Water
- Human Capital
- Low Appreciation for mining

Scenario B

- Tackling Mining Industry Challenges
Roadmap: 2035 Vision

- Produce between 130-150 millions tCuf between 2015-2035.
- 80% of production in two first quartile of cost

- 250 World Class Suppliers
- 10,000 MUS$/yr in technology and business services

Development of mining to address expectations of better quality of life and more well-being for all Chileans.

Sustained Global Leadership:
Improve industrial practices to rationalize demands and permits, better State control.

- Trusting and collaborative relationships among all actors
- Standards of community and labor relationships
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From natural resources to a knowledge-economy
Escaping the natural resource course

World Class Suppliers Program
“WCSP”
At a glance

- 44% of workers have a technical or professional title (26% of the Chilean population has this title).
- The sector employed more than a million workers in 2012 (13.7% of the country's population).
- Mining suppliers are found in the metropolitan region (66%).
- 34% of exported products and services are tied to the mining sector.
- 6,000 companies sell products and services to the mining sector.
- 36% of companies are incorporated within the last 5 years.
- 60% have increased the number of their own workers (2011-2012).
- 88% have increased sales (2011-2012).
The Global Mining Industry is Rich in Knowledge-Intensive Activities!
¿WHAT IS A WORLD CLASS SUPPLIER?

A Supplier, established in Chile, with a service of exportable quality
WCSP, a Collaborative Process of Value Creation

Mining Companies

challenge challenge challenge

Project Project Project

Suppliers

R+D

Universities
It’s impossible to do it alone
Mining Supplier’s Ecosystem

Mining Company 1
Mining Company 2
Mining Company 3
Mining Company N

SOLUTIONS

INNOVATION
- Energy
- Biotech
- Mechatronic
- Robotics
- ICT
- Software
- Services
- Metal mechanics
- Design
- Exploration
- Maintenance

TECHNOLOGY CENTER
- CEIS
- Consortium
- BASAL CENTERS

CorFO Instruments
- Technology Programs
- Basal for platforms
- Innovation and packaging
- Seed Capital
- R+D law
- Public goods and club
- Early stage Venture Capital

ACCELERATOR
- Dictuc
- 3ie
- Incubatec
- Incubatec
- Others

PRODUCTIVIDAD
- Technology solutions
- Projects
- Companies

FINANCING BASE FINANCEMENT FOR CAPACITY DEVELOPMENT

GOBIERNO DE CHILE | CORPORACIÓN DE FOMENTO DE LA PRODUCCIÓN · CORFO
Virtuous Cycle

Minning
- Strategic Industry
- World Class
- Large Scale
- Long Term
- Efficiency
- Results

Innovation and Entrepreneurship
- Open Culture
- Piloting
- Collaborative
- Scouting
- Anticipation

PPCM
Multiplier Effect
Suppliers  Source of Innovation
2009

BHP Billiton

2009
6 Mining Companies
73 Suppliers
92 Projects
51% Exports
500 MUSD sales
WCSP projects according to challenges

- **92** total projects
- **53** under development
- **39** finalized

- **Sustainability (HSEC)**: 23
- **Energy**: 11
- **Processing – Operational Efficiency**: 23
- **Maintenance – Operational Efficiency**: 20
- **Extraction – Operational Efficiency**: 7
- **Exploration – Operational Efficiency**: 2
- **Human Capital**: 2
- **Water**: 4
Company dedicated to the creation, design and implementation of **innovative solutions** based on technology, processes and applied engineering primarily in mining.

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**Aguamarina** provides evaluation, control and research services in Molecular Biology and Biotechnology. As well as biocorrosion, bioleaching and control of particulate matter.

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- Savings of USD $20mm
- Decrease of energy consumption
- Carbon footprint reduction in catode production
- Reduction from 17 to 10% of anodes left
- Efficient water use
- Environmental impact reduction
- 97% decrease of particle emissions
- Compliance of dust exposure for operators and communities
Mining, Information, Communication and Monitoring (MICOMO), technology services company, which seeks to adapt and commercialize services based in information and communication technologies.
Current portfolio

Scope of opportunities – Monitoring and Instrumentation

- Air quality monitoring – SO2; PM2.5; PM10; etc.
- Mining slopes monitoring
- Underwater tunnels monitoring
- Dry tunnels monitoring
- Water turbidity monitoring
- Idlers monitoring
- Mining pillars monitoring
- Hammers monitoring
- SAG mills instrumentation

Current portfolio
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Attracting the World’s Best

ENERGY

Building a Solar Energy Cluster
Energy Overview in Chile

Country Growth and Energy Demand

Installed capacity by energy type (SIC)*
## Project Stages in Chile

(In MW)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Operation</th>
<th>Construction</th>
<th>RCA approved, non constructed</th>
<th>In qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>461</td>
<td>0</td>
<td>94</td>
<td>70</td>
</tr>
<tr>
<td>Biogas</td>
<td>43</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Wind</td>
<td>836</td>
<td>165</td>
<td>5195</td>
<td>2209</td>
</tr>
<tr>
<td>Mini Hydraulic</td>
<td>350</td>
<td>134</td>
<td>322</td>
<td>203</td>
</tr>
<tr>
<td>Solar - PV</td>
<td>362</td>
<td>873</td>
<td>8064</td>
<td>3475</td>
</tr>
<tr>
<td>Solar - CSP</td>
<td>0</td>
<td>110</td>
<td>760</td>
<td>260</td>
</tr>
<tr>
<td>Geothermal</td>
<td>0</td>
<td>0</td>
<td>120</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2052</strong></td>
<td><strong>1282</strong></td>
<td><strong>14555</strong></td>
<td><strong>6225</strong></td>
</tr>
</tbody>
</table>

ERNC Project Stages (MW), November 30th. Source: CIFES, SEA, CDEC, CNE. December 2014.
Solar Radiation in Chile

Northern Chile Highlights

- World’s largest Copper & Lithium Reserves
- Driest place on the planet
- Atacama Large Millimeter Array (ALMA)
- San Pedro de Atacama
- 4,000 km² of land available

An obscene competitive advantage...untapped
Demand for Energy

Annual Demand Chile: 57000GWh/Year
Solar Potential in Chile: 236GW
Area Required (2.5ha/MW): 58000ha

Worldwide Energy Demand:
15000GW
Surface Area required:
37500000ha
Potential Clients

Mining Companies: BHP Billiton, Collahuasi, AMSA, Anglo American, Codelco, Xstrata, Kinross, TECK, Barrick, FPM, Caserones, Cerro Casales

Generating Companies: Enel, AES, GDF Suez
# Building a Cluster

## Companies:
- TIP: 3rd Independent Party,
- Data QA/QC Measurement and Analysis,
- Data Measurement Stations

## Services:
- Training:
  - Custom made projects:
    - Soiling Measurement,
    - Desalination Plants
Energy cluster

Valhalla Energy: Largest pump storage plant (300MW), USD 330M investment

Abengoa Solar: 1st Tower Thermosolar Plant with storage & direct grid connection in Latam (110MW), USD 1,000 b

First Solar: Largest PV Plant with direct grid connection (162MW), USD 370M investment

Fraunhofer Fokus – International Center for Excellence

Water for Mining

Technologies:

- Feasibility Studies
- Integral Site Water Management
- Acid Mine Drainage Prevention and Mitigation
- Water Reuse

Services:

- Water Footprint
- AWS
- Smart Water

Training & Standards:

- Water Footprint
- AWS
- Smart Water

New Water Sources:

- AquaAtacama (transport)
- WaterMoss (transport)
- Halobiolix (replacement)
HUMAN CAPITAL
Human Capital for Mining
Mining Skill Council ("CCM")

Sector initiative intended to address, collectively and coordinated, the necessary matching between mining labor demand and formation offer, both in qualitative and quantitative terms.

- Provide quality information pertaining to demand
- Establish quality bases and standards
- Define each profile requirements
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Mining Industry for Development

- In a country based on natural resources, knowledge-industries can be developed; from mining to other sectors.

- Helping to make the export portfolio more diversified and sophisticated, to promote the country’s development.

- Creating a virtuous cycle by joining entrepreneurship and innovation capabilities, with a strategic industry.
THANK YOU

FUNDACIÓN CHILE

ありがとう

ありがとうございます
Impact of suppliers in sector competitiveness continues to grow

Today, 60% of operational costs

Codelco’s evolution of costs

Insumos y Servicios de Terceros como Proporción del Costo Operacional Codelco
Millones de US$. Moneda de cada año
There was a vision: FCh’s strategy in solar energy

Establishment of Capabilities

Development

Industrialization and Internationalization

2007

Work in Regions: Solar Atacama Platform

Solar Thermal Industry:
Labor Skills and quality assurance

Specialized Services, measurements, technology performance, plant inspection (Alliance with CENER)

2010

PV Solar Development Model: SolarChile

S. Energy Applications: Cogeneration, Water desalination, mining processes, storage

Expansion LATAM

Integration and Manufacturing

Services Sector (Mining Cluster)

Pilot Plants C4E

2020
The Dream

Denmark
Wind

Iceland
Geothermal

Chile
Solar
Mining Information Communications and Monitoring S.A.
The beginning · MICOMO

Created on 2006 by Codelco and NTT

MISSION:
To adapt and commercialize technology based services and advanced information systems, monitoring and telecommunications developed by NTT and others, applicable to the mining and other relevant industries.
The plan was...

- **MICOMO**
- **CODELCO Strategic Needs**
- **R&D NTT Products**

**Validated Technology**

**Pilot Programs**

**New ideas / needs**

**World Mining Industry**

**Other relevant Industries**

**Commercial Product MICOMO**
Current Business Development Focus

**BOTDR**
- Tinguiririca
- SMM DET PICA ROCAS
- DMH Material Heap
- Rio Blanco
- Sweden

**PHOTONICS**
- Codelco Andina
- Codelco Teniente

**ENVIRONMENT**
- Particulated impact DSAL
- Water savings SPENCE
- Water savings CODELCO Gaby

**DIVERSIFICATION**
- Aguas Andinas: PIO
- Elecmetal - Micrológica
Company dedicated to the creation, design and implementation of innovative solutions based on technology, processes and applied engineering primarily in mining.

**CHALLENGE:** Reduce anode that must be recycled after electrorefinement process.

**PROJECT:** Diminish Scrap in Processesing of High Purity Copper Anodes.

**SOLUTION:** Elimination of copper anode ears, being replaced by artificial ear for handling – called «Earless».

- Savings of USD $20mm
- Decrease of energy consumption
- Carbon footprint reduction in cathode production
- Reduction from 17 to 10% of anodes left

Operational Efficiency
Aguamarina provides evaluation, control and research services in Molecular Biology and Biotechnology. As well as biocorrosion, bioleaching and control of particulate matter.

**CHALLENGE:** Ensure compliance with emission standards of suspended particulate matter PM10 generated by the crushing operational process, decreasing the exposure of operators.

**PROJECT:** Reduction of Suspended Particulate Matter from Stationary Sources.

**SOLUTION:** Design of a system to remove particulate matter emission fixed points in the transfer of the ore crushing area using water and an organic compound produced by EPS bacteria algae, which captures dust by electrical charge.

- Efficient water use
- Environmental impact reduction
- 97% decrease of particle emissions
- Compliance of dust exposure for operators and communities

Health  Communities  Environment
Mining, Information, Communication and Monitoring (MICOMO), technology services company, which seeks to adapt and commercialize services based in information and communication technologies.

**CHALLENGE:** Management of particulate matter, to minimize the impact of this pollutant around the mine.

**PROJECT:** Environmental impact forecast of particulate matter.

**SOLUTION:** Implement a tool of air quality that monitors the environmental conditions and allows to manage with anticipation measures of particulate material MP10, through the use of water in the irrigation plans of the mine.
Process Technology Innovation Is Not Enough to Leverage the Entire Opportunity

Projected maximum production capacity of copper mine, according to condition

Source: COCHILCO, 2014
A Holistic and Concerted Approach

1. Improvement of productive base, investment development and exploration for sustainable mining

2. Collaborative R&D&I Programs

3. Knowledge-intensive equipment, technology & services export industry

4. Development of critical human capital capacities & labor relations for sustainability

Technical, Economic, Social & Environmental Challenges

Enabling institutional framework, with orchestration & monitoring capacity that generates greater adhesion and legitimacy
...with the Generation of Shared Value

- Solution to mining site problems
- Improve productivity and competitiveness
- Access to real scale test lab
- Improve technology offer and business capabilities

- Improves competitiveness
- Improves productive chain capabilities
- Development of sector intensive in knowledge and technologies, capable of exporting products and services to other latitudes

- Transversal problems solutions
Vision

Low Carbon Copper

Low Emission Grid

Utility Scale Solar Park

Desalination

Zero Emission H2

Clean Manufacturing

Green Data Center
VetaMinera 2013
Gaps in Human Capital

- **20** Impacted cities
- **35%** Women graduated
- **170** Companies in Work Intermediation Network
- **2,360** People in Training Courses
- **1st Place** Mining Film Fest
- **USD 18 MM** State Investment on Scholarships 2013
- **32,000** Talents applying to Work Training