CHILE’s STRATEGY FOR INNOVATION IN ENERGY TRANSITION AND LOW EMISSION MINING

14th Annual General Meeting IGF 2018
Modern Mining Law and Policy: Accountable, Equitable and Innovative Approaches

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CORFO, the Chilean Economic Development and Innovation Agency (since 1939)

Our Mission is to improve the competitiveness and the productive diversification of the country by encouraging investment, innovation and entrepreneurship, strengthening in addition the human capital and technological capabilities to achieve a sustainable and territorially balanced development.

- **13,833** beneficiaries in 2017
- More than **1,000** Startups supported in 2017
- **800** innovation projects in companies in 2017
- **+35** R&D Consortia linking industry and academia
- **20** Technology Centers
- **150,000** credits and guarantees granted to SMEs
- More than **50** VC funds and close to **US$ 900 million** in available funds
VISION 2035: Chile has developed a technology-based mining industry that addresses productivity challenges with a robust collaborative innovation ecosystem with the industry, suppliers, R&D entities, and public sector.

250 world class suppliers

US$ 4 billions exports in goods and services
TECHNOLOGY ROADMAP 2035

A public-private collaborative approach

70 Interviews with key actors
3 Technical groups with experts
1 Challenge Prioritization Workshop

+90 Actors Workshop participants
63 Institutions
1,600 Work hours involved

17 Challenges
58 Solutions
109 R&D Lines

TRACTION AREAS

ENABLING AREAS

MINING OPERATIONS & PLANNING
MINERAL CONCENTRATION
HYDROMETALLURGY
SMELTER & REFINERY
NEW USES OF COPPER

SUPPLIERS & INNOVATION
HUMAN CAPITAL
SMART MINING
GREEN MINING
Providing QUALITY, RELIABLE AND REAL-TIME INFORMATION (chemical and physical stability) to mining companies, communities and authorities, STRENGTHENING operational management, PROMOTING a risk culture and IMPROVING communication between the parties and the response to eventual emergencies situations.

Total Budget for 5 years: MMUSD 7,6 - MMUSD 4,6 granted by Corfo
HIGH VALUE MINERALS FROM TAILINGS CONSORTIA

Promoting a secondary mining industry from Tailings

• 2 R&D Consortiums supported by Corfo are developing strategies and technologies for recovering high value minerals from tailings, such as rare earths, cobalt and others.

• The strategy is to promote re-processing some tailings to extract remanent Copper and Molybdenum, as well as high value minerals, helping to close in a sustainable way old or abandoned ones.

Total Budget for 5 years: MMUSD 3,7 - MMUSD 2,2 granted by Corfo

Total Budget for 5 years: MMUSD 2,5 - MMUSD 1,5 granted by Corfo
MINING OPEN INNOVATION PLATFORM FOR SUPPLIER DEVELOPMENT

Stakeholders

- Suppliers
- Startups
- Universities & Research Centers
- Financing
- Government
- Mining Companies

Coordinated by
- FCH
- Codelco
- BHP
- Antofagasta Minerals

Process:
1. Technology Characterization & Release
2. Technology Mapping
3. Portfolio Management
4. Ecosystem Linkage
5. Suppliers Development
6. Mining Productivity
7. Financing Strategies
8. Scale-up Strategies

Business Management

Technology Management
Interoperability is an enabling platform to smart, connected mining operations.

- Develop and promote guidelines
- Facilitate bench tests
- Contribute to standards development (link to ISO working groups and GMG)
- Disseminate a maturity model for suppliers development

Total Budget for 5 years: MMUSD 7 - MMUSD 4 granted by Corfo

Fuente: Corfo
A VIRTUOS CIRCLE: ELECTROMOBILITY, RENEWABLE ENERGY, GREEN MINING

ELECTROMOBILITY

RENEWABLE ENERGY

GREEN MINING

LITHIUM
COPPER
COBALT AND OTHER MINERALS
A UNIQUE OPPORTUNITY FOR CHILE

Atacama Desert singularities

- **Highest solar potential**
  - >3.500 kWh/m²
  - >4.000 sun hours/year

- **Biggest metallic mining district in the world**

- **Strong position in non metallic mining** - lithium production and natural nitrates

Opportunities for Chile

- **Global trend**: exponential growth of electromobility and hydrogen-based economy

  - Increased demand of lithium.

  - Increased demand of copper (additional 2 - 4 millions tons of low emission copper).
Vision 2030: Chile as leading supplier of lithium and low-emission copper for the electric car industry

World's leading lithium producer

World's largest low emission copper producer

Long term supply of lithium carbonate/hydroxide (battery grade)
Lithium added value products (cathodes, others)
Solar energy for continuos electricity supply (mix PV/CSP) at average cost of 50 USD/MWh
Fossil fuels substitution
Hydrogen and Syntetic fuels based on circular economy approach
• The Chilean government owns the lithium resources in the Atacama salt flat through Corfo, the Economic Development Agency. 2 current contracts:
  - Albemarle: 140 kTons de LCE hasta 2043
  - SQM: 216 kTons de LCE hasta 2030
• Chile owns more than 50% of the world reserves.
• Call for local manufacture of added value lithium products
SOLAR PV FOR HIGH RADIATION CONSORTIA

To adapt and/or develop solar photovoltaic power technologies that respond better to the unique conditions in desert and high-radiation regions

- Reduce LCOE by 2025
- Increase performance and durability
- Develop local industry

Total Budget 7 years: MMUSD 20 - MMUSD 12 granted by Corfo
HYDROGEN IN MINING CONSORTIA

To adapt or develop technologies aimed to substitute ≥ 50% fossil fuels in mining haul trucks and underground fleets

- Reduce diesel consumption
- Reduce CO2 emissions
- Develop local industry

Total Budget for 5 years: MMUSD 20 - MMUSD 5,8 granted by Corfo

Total Budget for 5 years: MMUSD 2,2 - MMUSD 1,1 granted by Corfo
Seeks to articulate the copper value chain to respond effectively to the requirements of the market and society, through a system of traceability in all its stages and thus achieve sustainable and responsible practices.

MARKET TRENDS ARE REFLECTED ACROSS THE VALUE CHAIN

8 DIMENSIONS

- Emissions footprint
- Water footprint
- Carbon footprint
- Respect for Human Rights
- Health and occupational safety
- Impact on communities and territories
- Transparency, ethics and compliance
- Inclusion and gender parity

3 Partnerships (to date)
SOLAR MINING TECHNOLOGY INSTITUTE – RFI stage

INTERNATIONAL REQUEST FOR INTEREST END OF OCTOBER 2018 TO CREATE A CONSORTIA (INDUSTRY, TECHNOLOGY CENTERS, UNIVERSITIES)

THE INSTITUTE WILL RECEIVE RESOURCES FROM THE R&D ROYALTY OF THE LITHIUM CONTRACTS
~ MMUSD 150-200 IN 10 YEARS

SOLAR ENERGY
- Solar PV high radiation
- CSP and storage
- Solar Fuels

LOW EMISSION MINING
- Circular economy approach to mining
- Novel low emission mining and metallurgy process
- Traceability (CO2, others)

ADVANCED MATERIALS FOR ELECTROMOBILITY AND ENERGY STORAGE
- Lithium, copper and other metals added value products
- Improved molten salts for storage
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