



MINING AND COPPER INNOVATION OPPORTUNITIES

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CHILE, MINING COUNTRY

Chile is the largest copper producer in the world and owns 30% of world's reserves

Mining has concentrated more than 60% of the country's exports (10 years average)

Has contributed with 20% of public budget (10 years average)

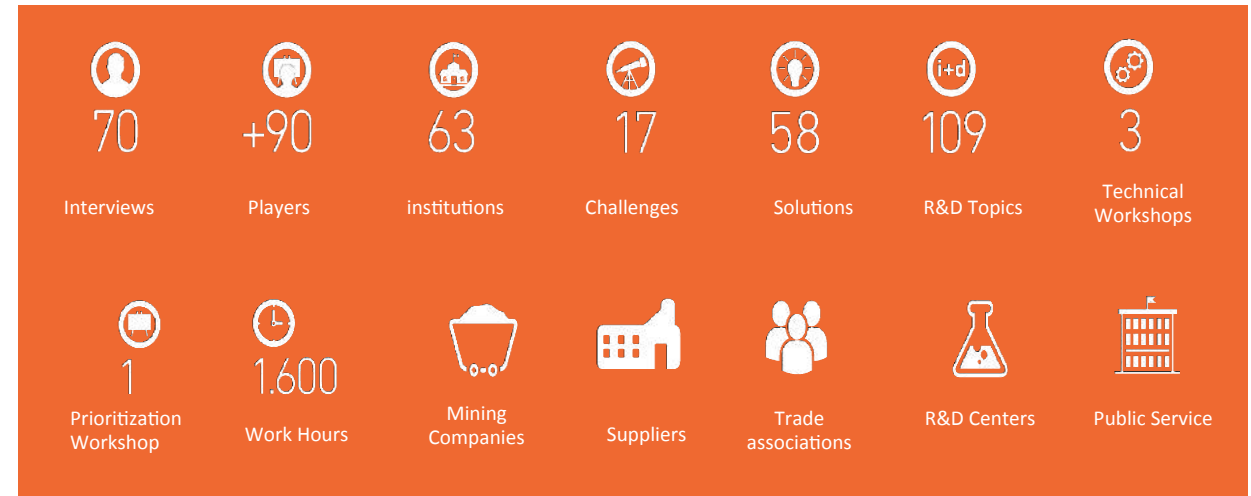
Has contributed 13% to the national GDP (10 years average)

Consolidates 11% of employment (direct and indirect)

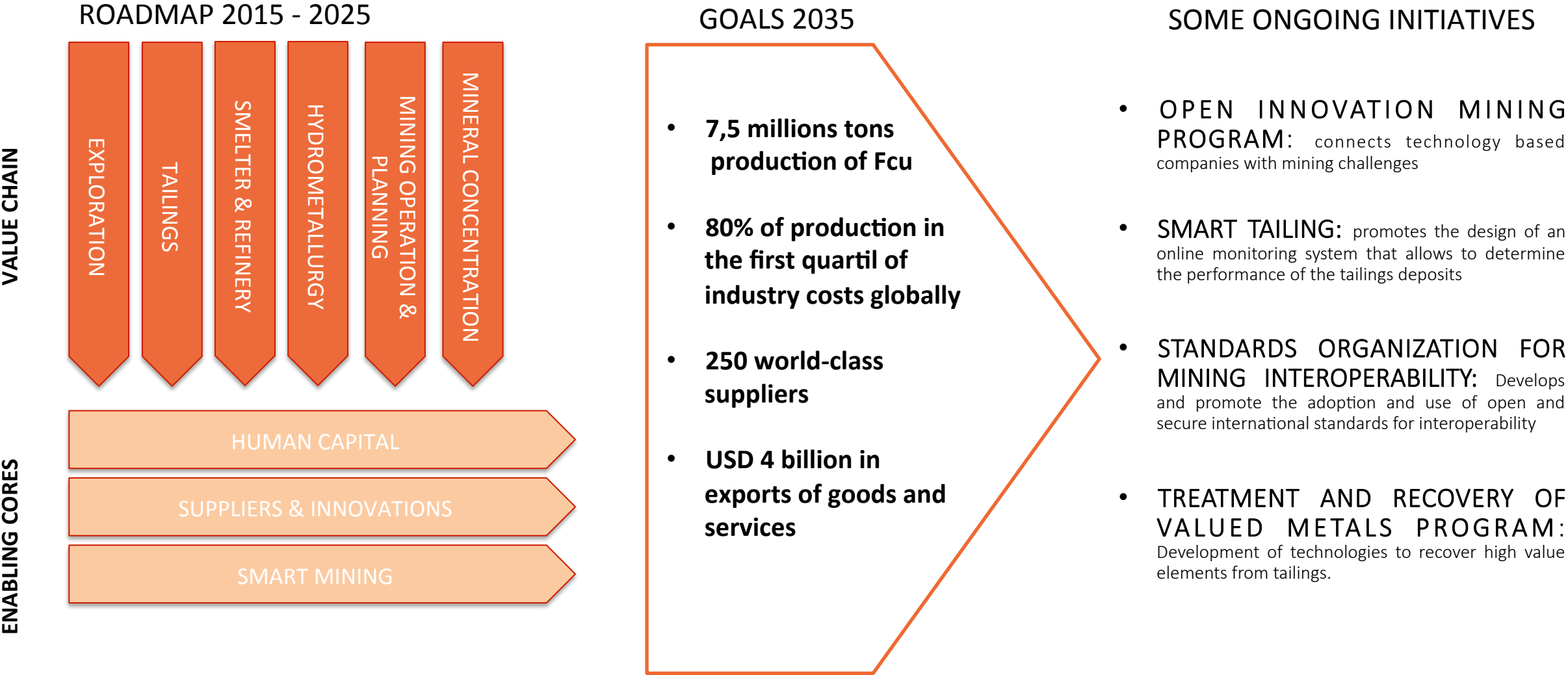


CHILE, NATIONAL MINING PROGRAM

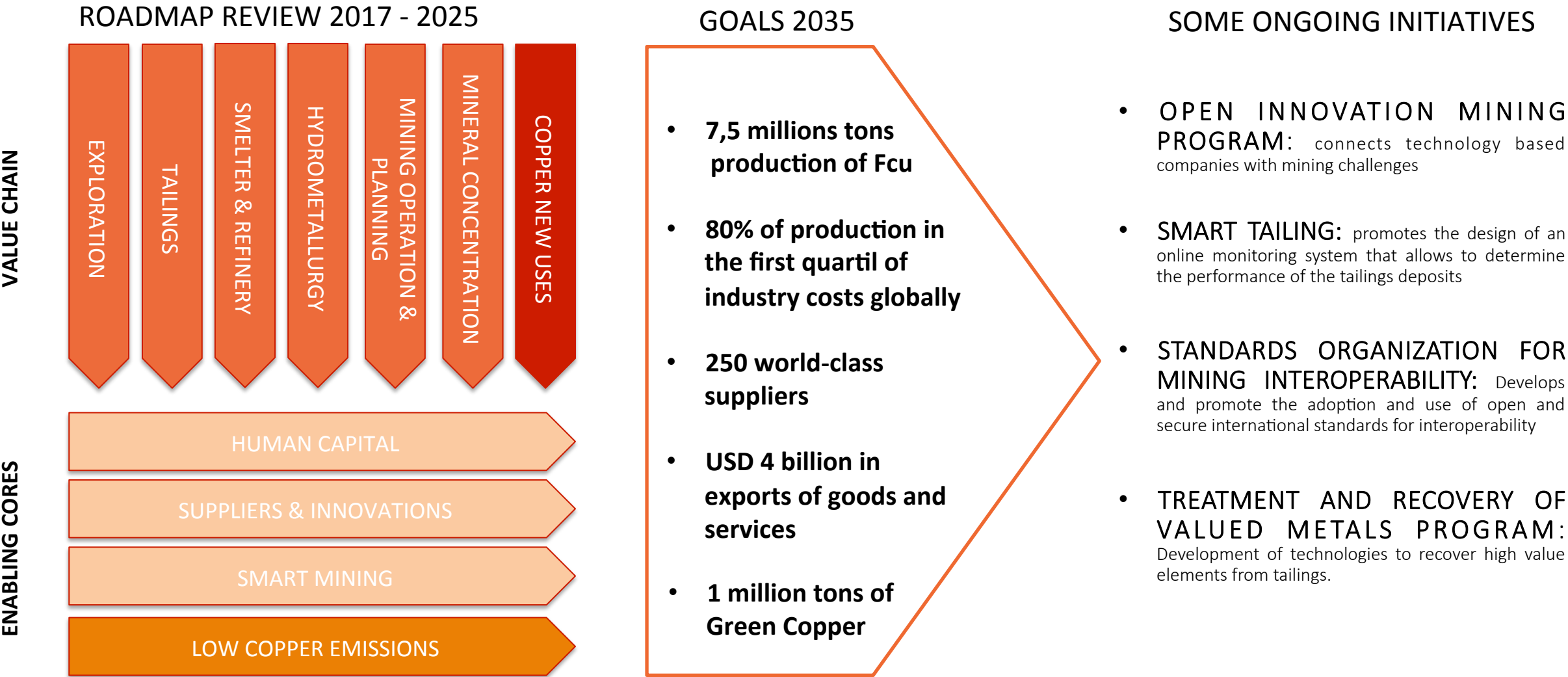
Chile in 2015 developed a National Mining Program named Alta Ley created by Corfo and the Public Mining Ministry that aims to strengthen productivity, competitiveness and innovation in the national mining industry and its suppliers, in order to boost the country's development.



CHILE, NATIONAL MINING PROGRAM



CHILE, NATIONAL MINING PROGRAM



CODELCO, **BIGGEST COPPER PRODUCER**



100% state-owned company. **It has the world's largest copper reserves.**

In 2016, Codelco produced 1.8 M ton of fine copper or **10% of the world's copper production, being the 1st producer worldwide.**

World's second molybdenum producer in the world

Will invest US\$ 20,000 M in operations improvements during 2015-2019



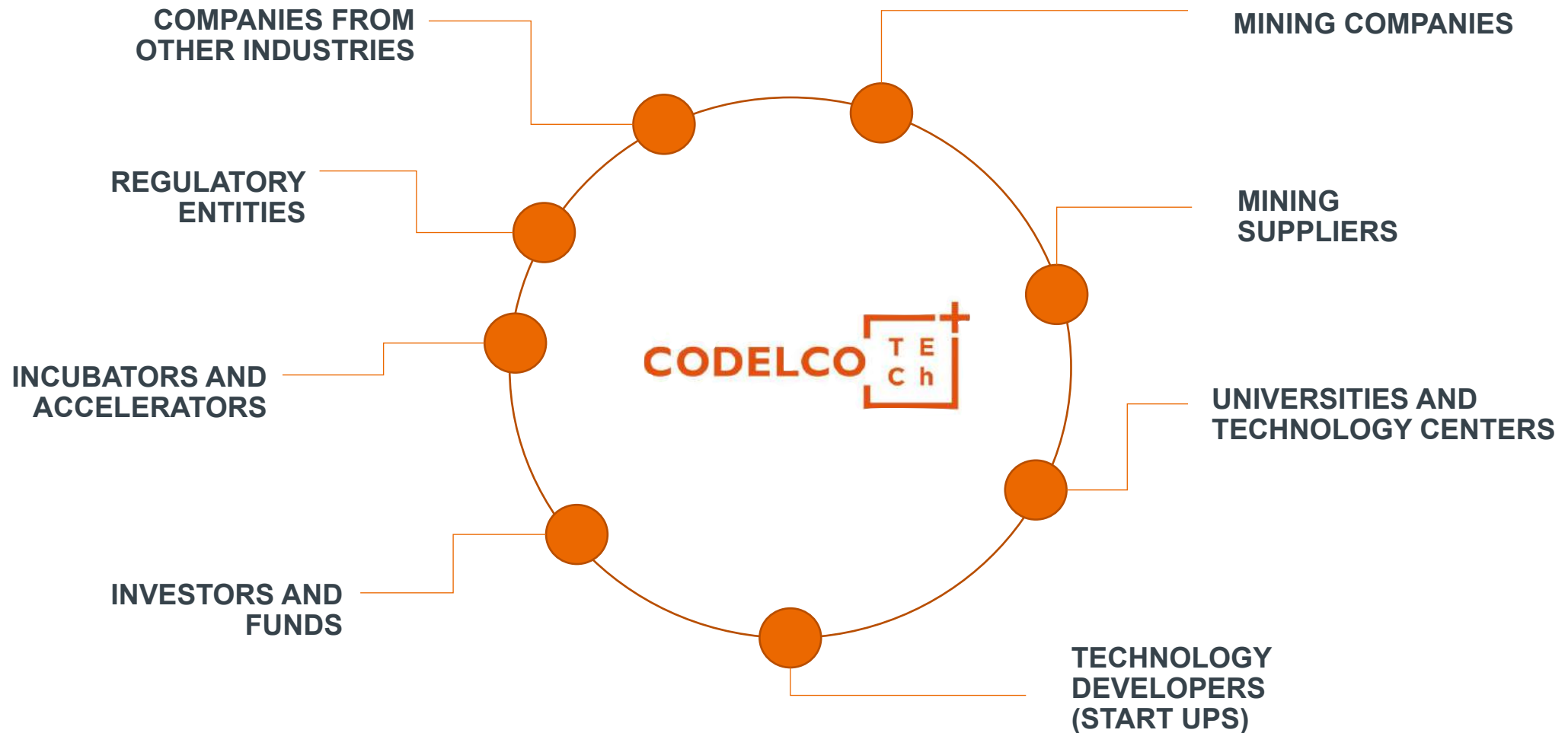
PARTNER FOR DEVELOPMENT AND IMPLEMENTATION OF TECHNOLOGICAL INNOVATIONS TO SOLVE MINING CHALLENGES

Technology and project development's process that generate high impact innovations for mining

Articulates an open innovation model for project development

Owns capabilities to prototype, validate technologies and generate new business models to make the technologies growth

OPEN INNOVATION AND COLLABORATION



INNOVATION MANAGEMENT

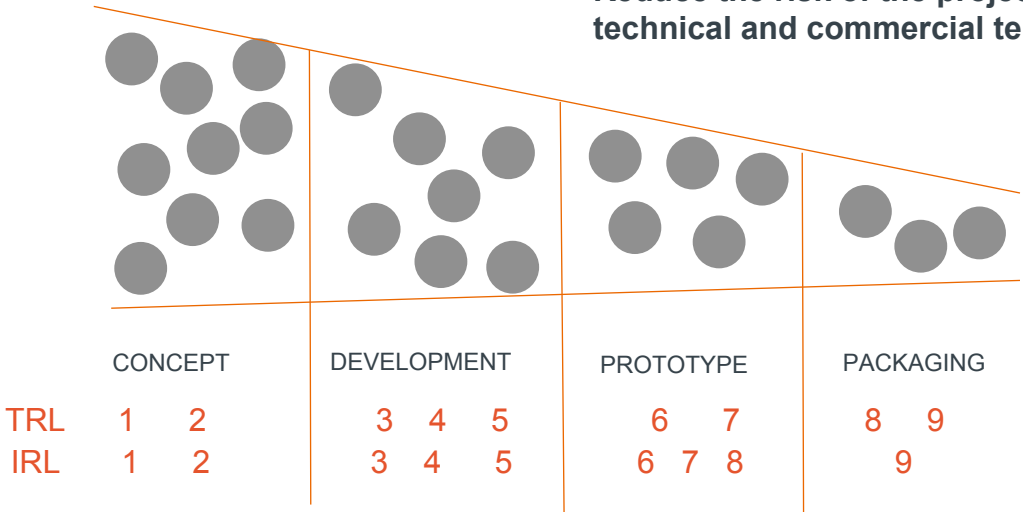


Identify opportunities for the Mining Industry

- Rising problems and challenges.
- Trend Visibility
- Evaluation of initiatives
- Strong relationship with SH
- Market intelligence
- Technological surveillance



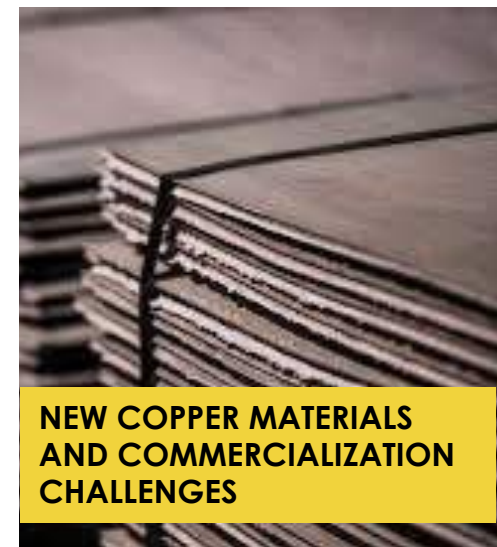
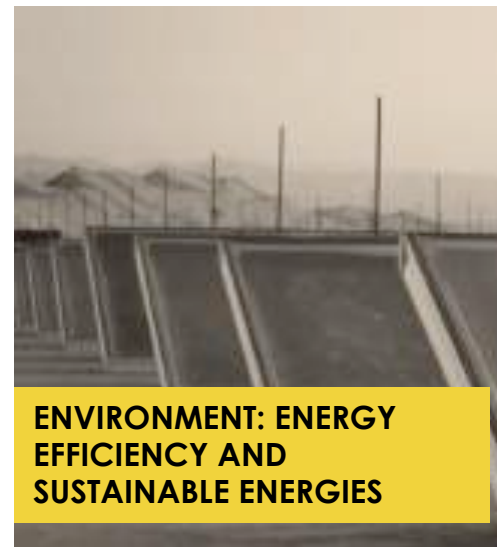
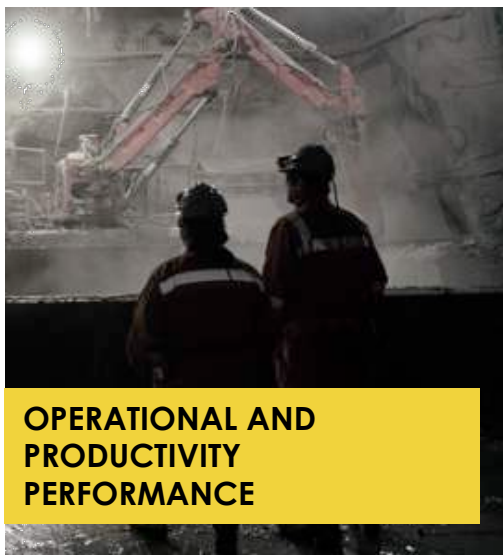
Reduce the risk of the project in technical and commercial terms.



Value capture for projects developed:

- Contract administration.
- Implementation in real operation, other mining companies, other industries.
- Post sales services with customers
- Technology and capability transfer / Development of Spin Off
- Connect with investors / investment funds (i.e US\$50M which Codelco is part of)

CHALLENGES **TO SOLVE**



INNOVATION MANAGEMENT

No Projects
40+

SYMBOLY

OPERATIONAL AND PRODUCTIVITY PERFORMANCE

OCCUPATIONAL SECURITY AND SAFETY

ENVIRONMENT: ENERGY EFFICIENCY AND SUSTAINABLE ENERGIES

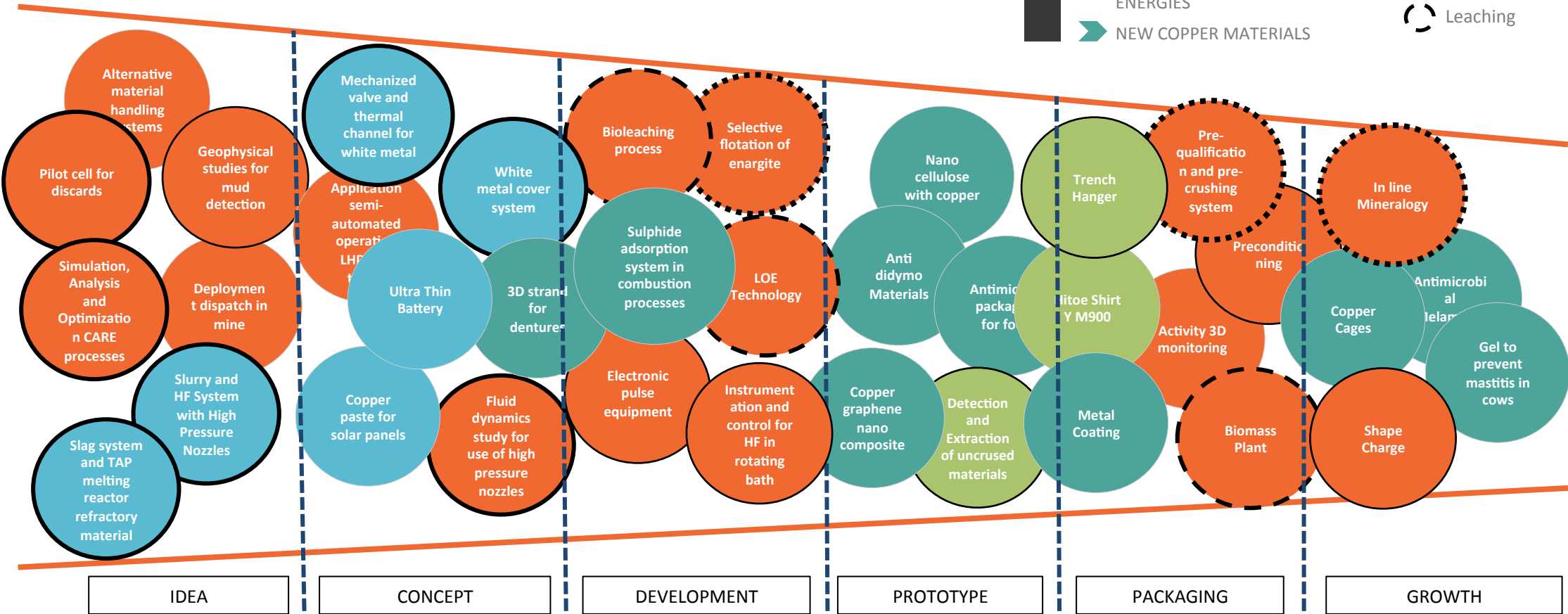
NEW COPPER MATERIALS

○ Mine

⊗ Concentrator

⦶ Smelting and refining

⦶ Leaching



TAILINGS SUSTAINABILITY

R&D Project

STAGE: CONCEPT

PHYSICAL AND CHEMICAL
STABILITY

RECOVERY OF HIGH
VALUE ELEMENTS

BENEFITS PROVIDED TO OPERATIONS

- **Transformation of environmental mining liabilities into assets.** Some of the elements that could be recover are gallium, phosphates, rare earths, tellurium, chromium, cobalt, scandium, selenium, uranium, titanium and manganese.
- **Reduce the environmental impact of tailings.** Stable tailings (physically and chemically) contribute to compliance with the norms of mine decommissioning.

POSSIBILITIES IN OTHER INDUSTRIES

Any mining tailings: golden, silver, iron, etc

CURRENT STATUS OF THE PROJECT

Projects starts on 2017. Currently doing the technology surveillance and pre selection of elements of value.



ENHANCING **NEW MATERIALS** FROM COPPER PROPERTIES

Technology Transfer and Collaboration Project

STAGE: DEVELOPMENT

COPPER – GRAPHENE NANOCOMPOSITE

In collaboration with:
Korean Technology Center,
Chilean University,
Chilean Start Up.

BENEFITS PROVIDED.

- **Improvements of mechanical properties:** friction, wear, strenght.

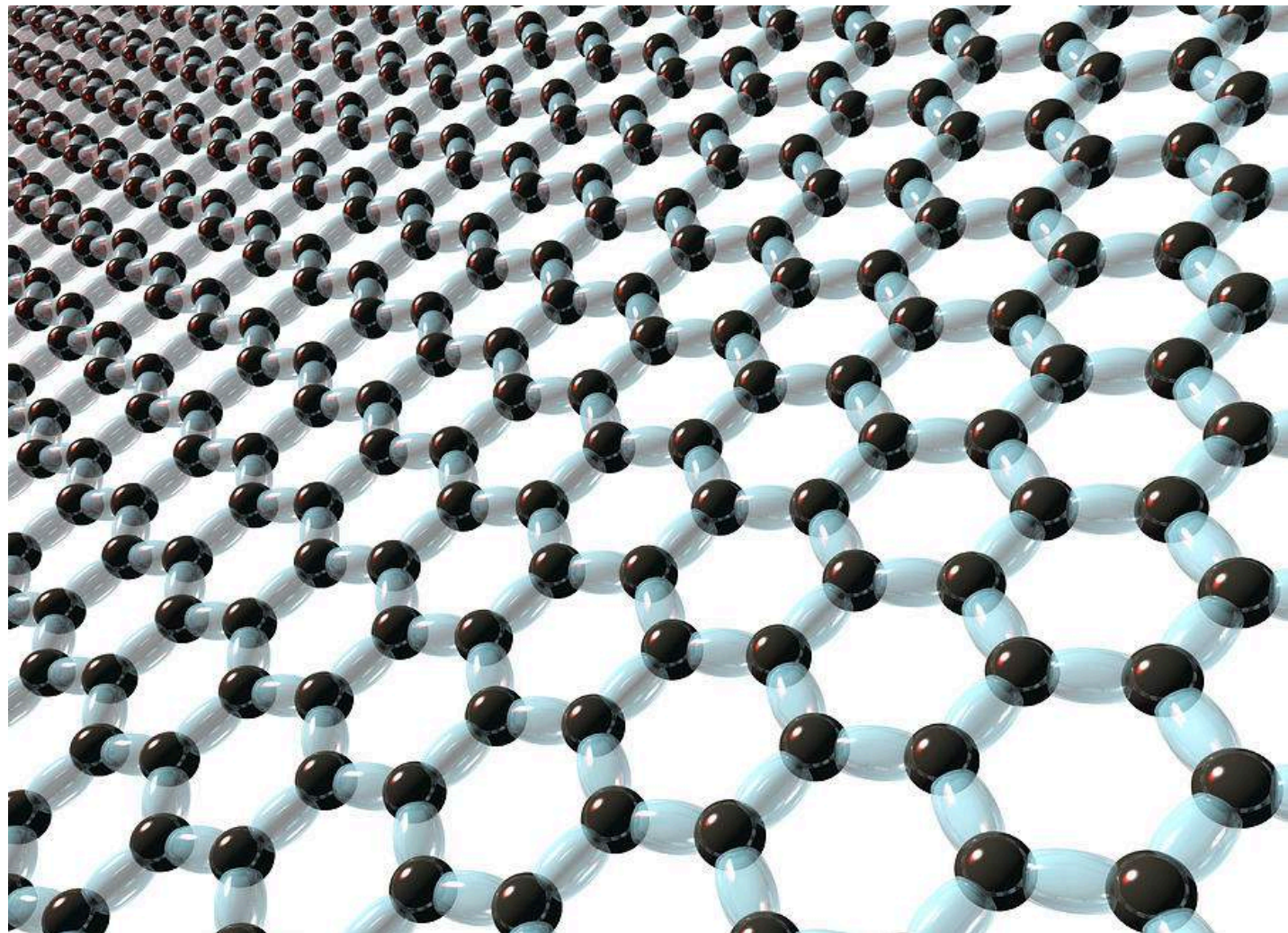
INDUSTRIES POSSIBILITIES

- Electric Connectors
- Brushes for electric motors, piston pins or connecting rod.
- Bearings for ships, machines, etc.
- Eolic energy generation

CURRENT STATUS OF THE PROJECT

Technology being tested in the Chilean University.

Market surveillance and business model in development by Codelco Tech.



REAL-TIME IDENTIFICATION OF THE MINERAL SPECIES PROJECT

R&D Project

STAGE: PACKAGING

REAL TIME
MEASUREMENT
EQUIPMENT

CHARACTERIZATION OF
MINERAL SPECIES AS PYRITE,
ENARGITE, CHACOPYRITE,
COVERLTE, AMONG OTHERS.

BENEFITS PROVIDED TO OPERATIONS

- **Increase in copper recovery** in the mine tested
- **Savings in the suppliers consumption** due its advance detection of material composition
- Benefit to mine tested: US\$3,8M to 7,2M
- **Potential benefits to large scale operation: US\$30M – 56,4M estimated**

POSSIBILITIES IN OTHER INDUSTRIES

Construction - Cement

CURRENT STATUS OF THE PROJECT

- **Technology validated in a mine with real conditions**
- Packaging and **preparing to transfer to other mines.**



REDUCTION OF LEAD TIMES IN MINERAL EXTRACTION PROCESS

Technology Transfer and Development Project

STAGE: GROWTH

TECHNOLOGICAL
INTEGRATION OF A
SHAPE CHARGE

IMPROVE
PRODUCTIVITY

BENEFITS PROVIDED TO OPERATIONS

- **Reduces operators exposure to risks.**
- **Decrease the extraction variability**
- **Increase production** due to less lead times.
- Benefit to mine tested: 840 tons produced per day equivalent to US\$8M.
- **Potential benefits to large scale operation :
US\$ 150M - 200M estimated**

POSSIBILITIES IN OTHER INDUSTRIES

Demolitions
Oil extraction

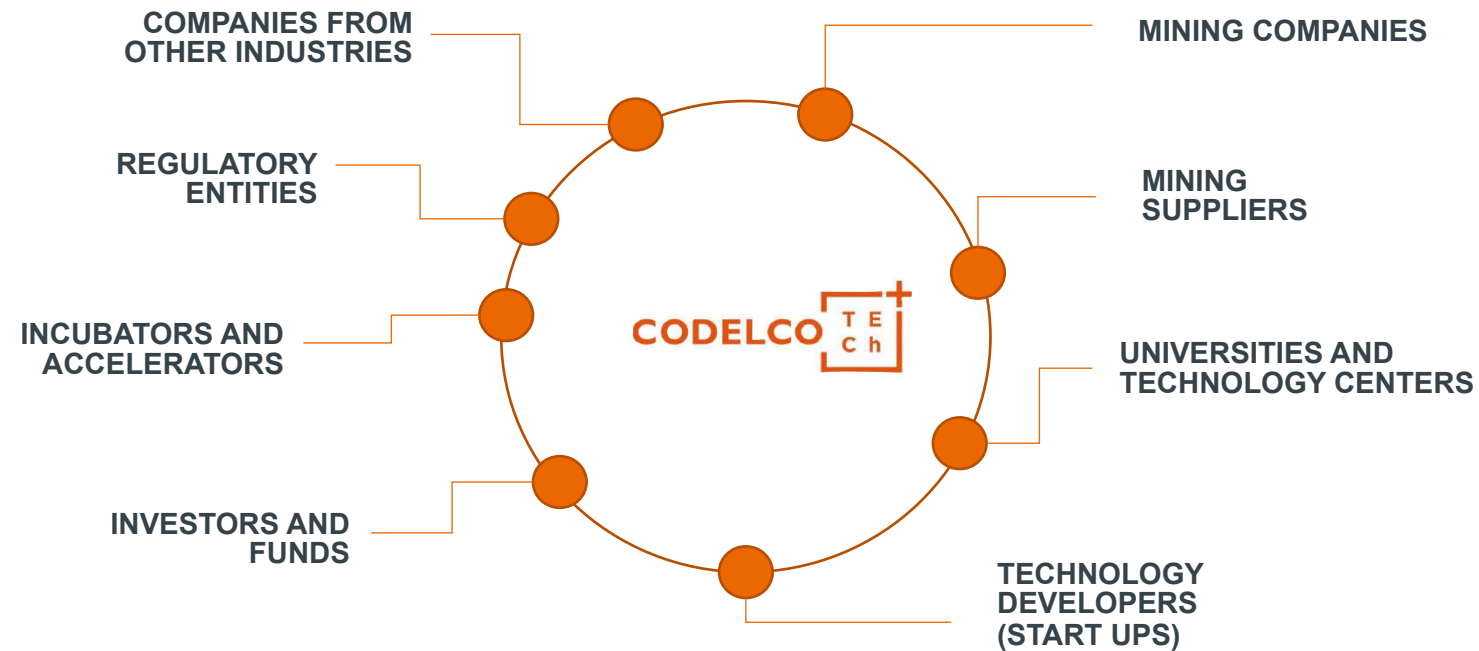
CURRENT STATUS OF THE PROJECT

- **Technology validated in a mine in real conditions.**
- **Beginning its implementation to the rest of the operations.**



COLLABORATION OPPORTUNITIES

Codelco Tech applies an **open innovation model** where entities from other industries can **collaborate** in the development of mining innovation projects



SHARE MINING CHALLENGES TO SEEK COLLABORATIVE SOLUTIONS
Develop collaborative projects for the mining sector

EXPLORE TECHNOLOGICAL TRANSFER OPPORTUNITIES
Expansion of technologies to mining and new markets

THANKS

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Desarrollo e implementación de innovaciones tecnológicas

+40

Proyecto

S en

desarrollo

+20

Proyecto

S

implementado

S

y en

PROCESOS
MINEROS

BIOTECNOLOGÍA

MATERIALES

AUTOMATIZACIÓN

DATA
SCIENCE

SIMULACIÓN Y
MODELACIÓN

Y MÁS

