

arsenic
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**CODELCO INNOVATION STRATEGY:
ECOMETALES LIMITED,
APPLIED INNOVATION**

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Arsenic

A great challenge



The depletion of oxidized minerals and the beginning of the exploitation of complex sulphides implies the treatment of more impurities.

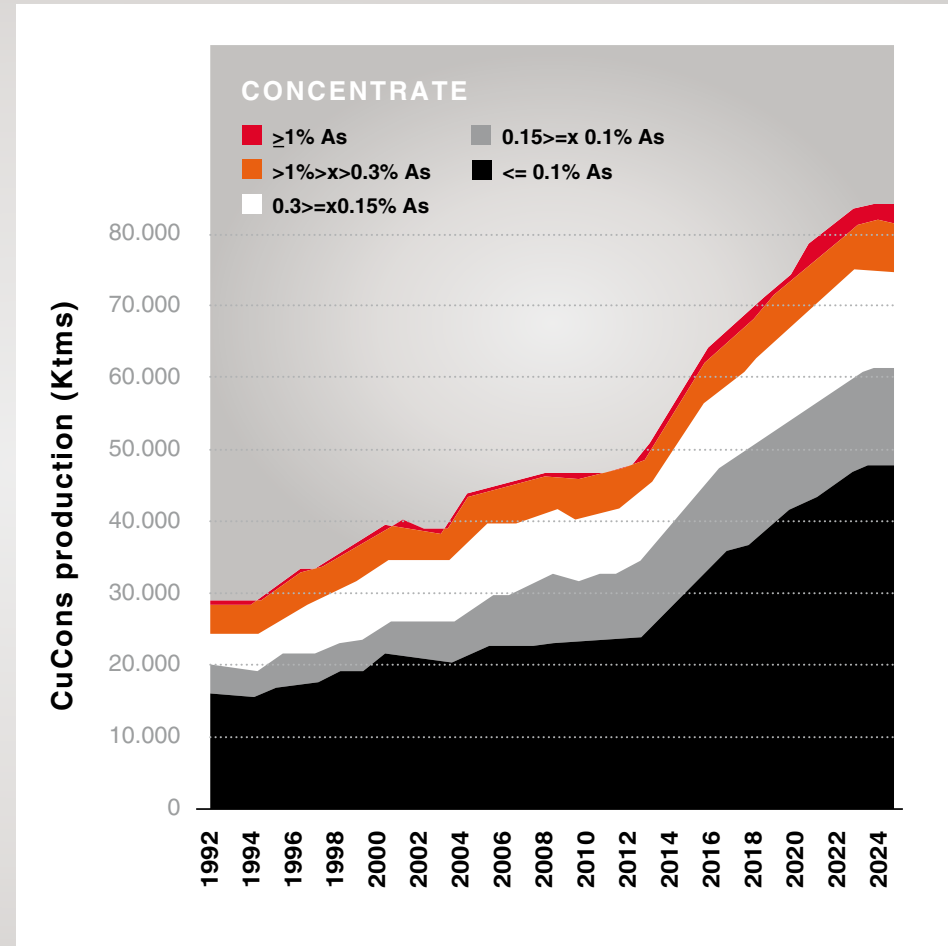
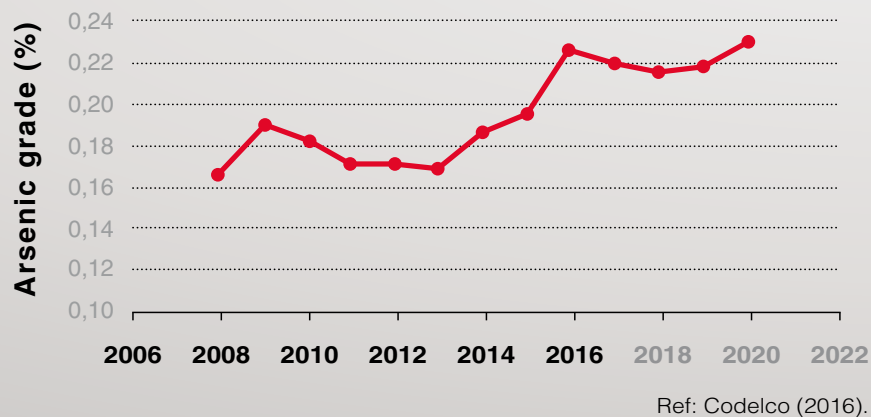
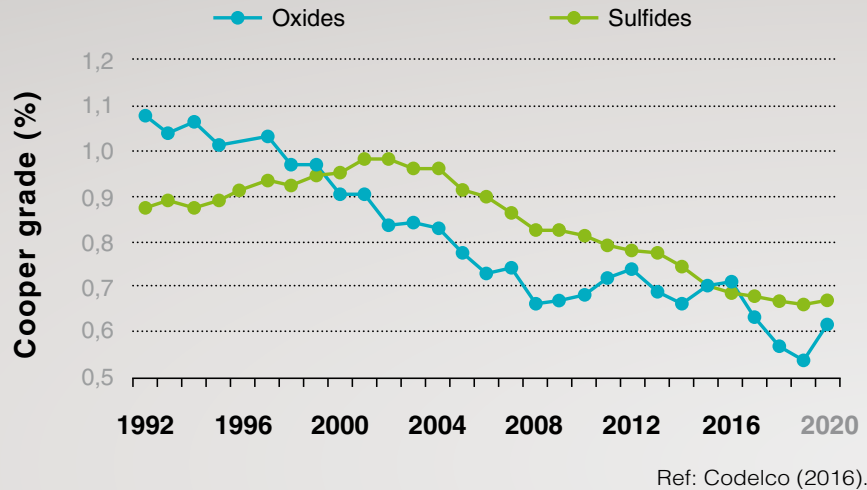
Increase of environmental restrictions.

Waste should be treated more efficiently in order to reach authorized limits.

Recovery of valuable elements contained in the waste becomes an imperative.

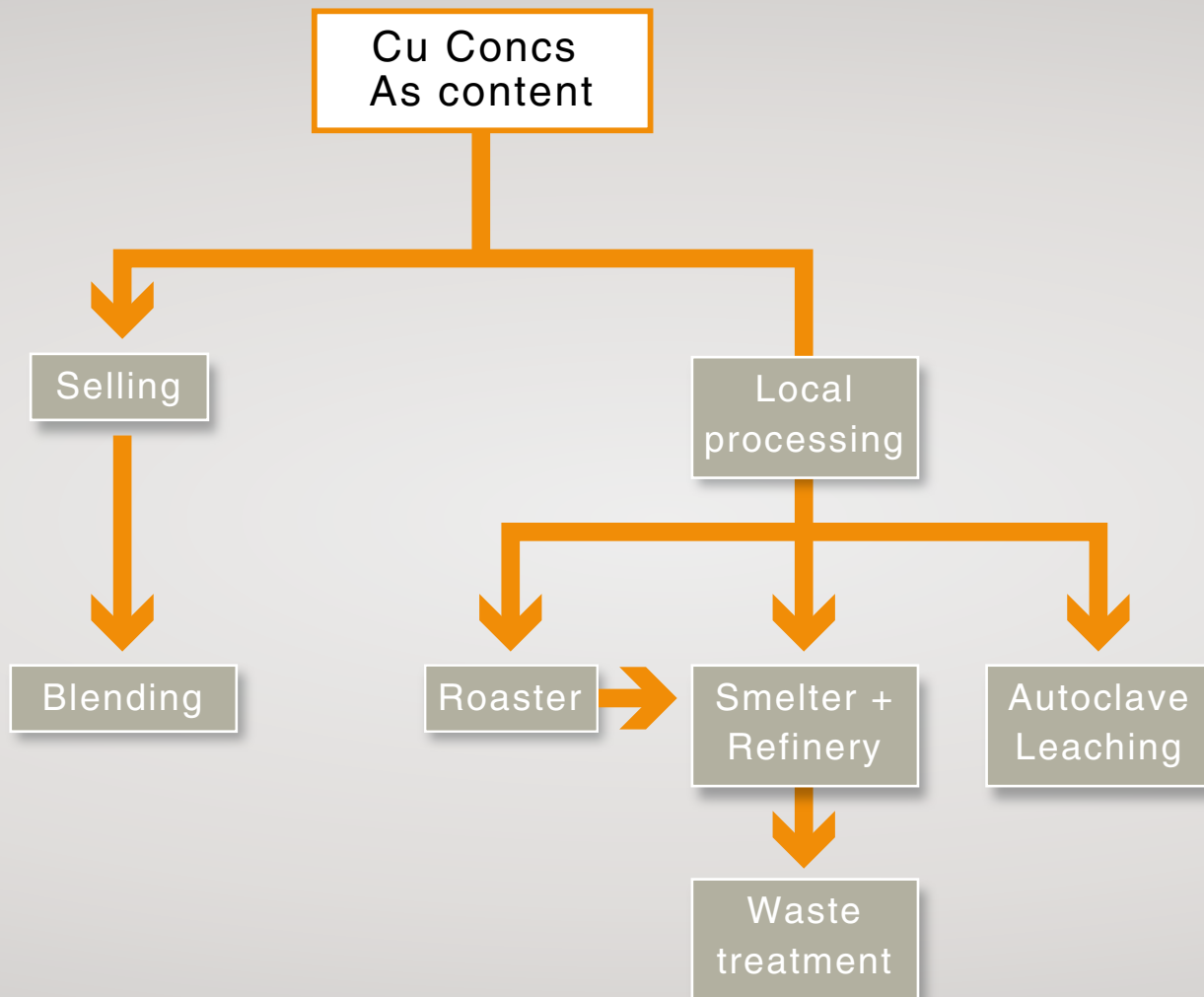
Arsenic

Solving the arsenic problem is a priority



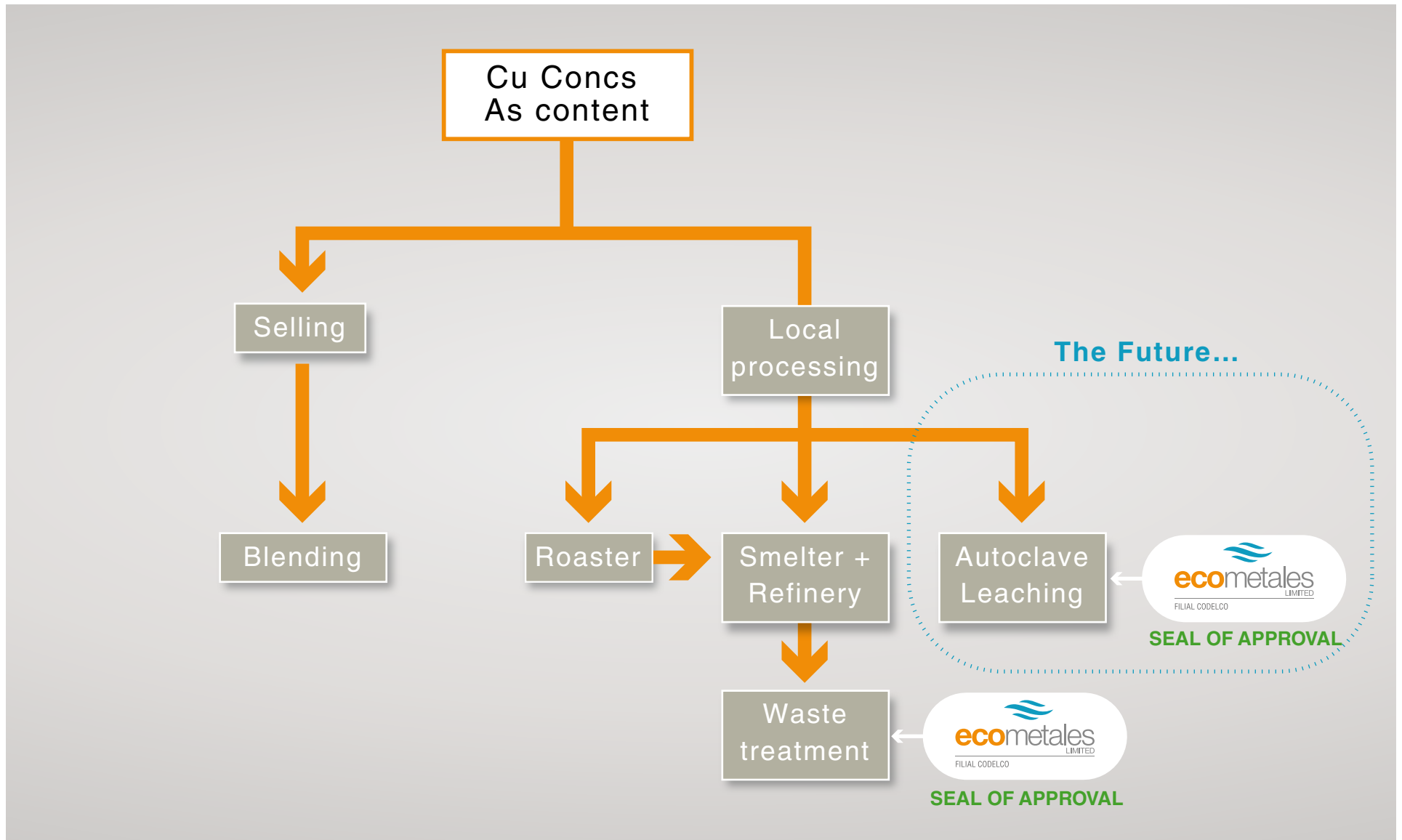
Copper mining industry

Current and future scenarios



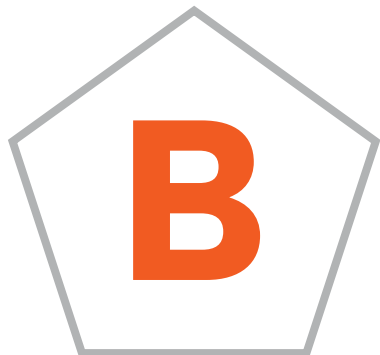
Copper mining industry

Current and future scenarios





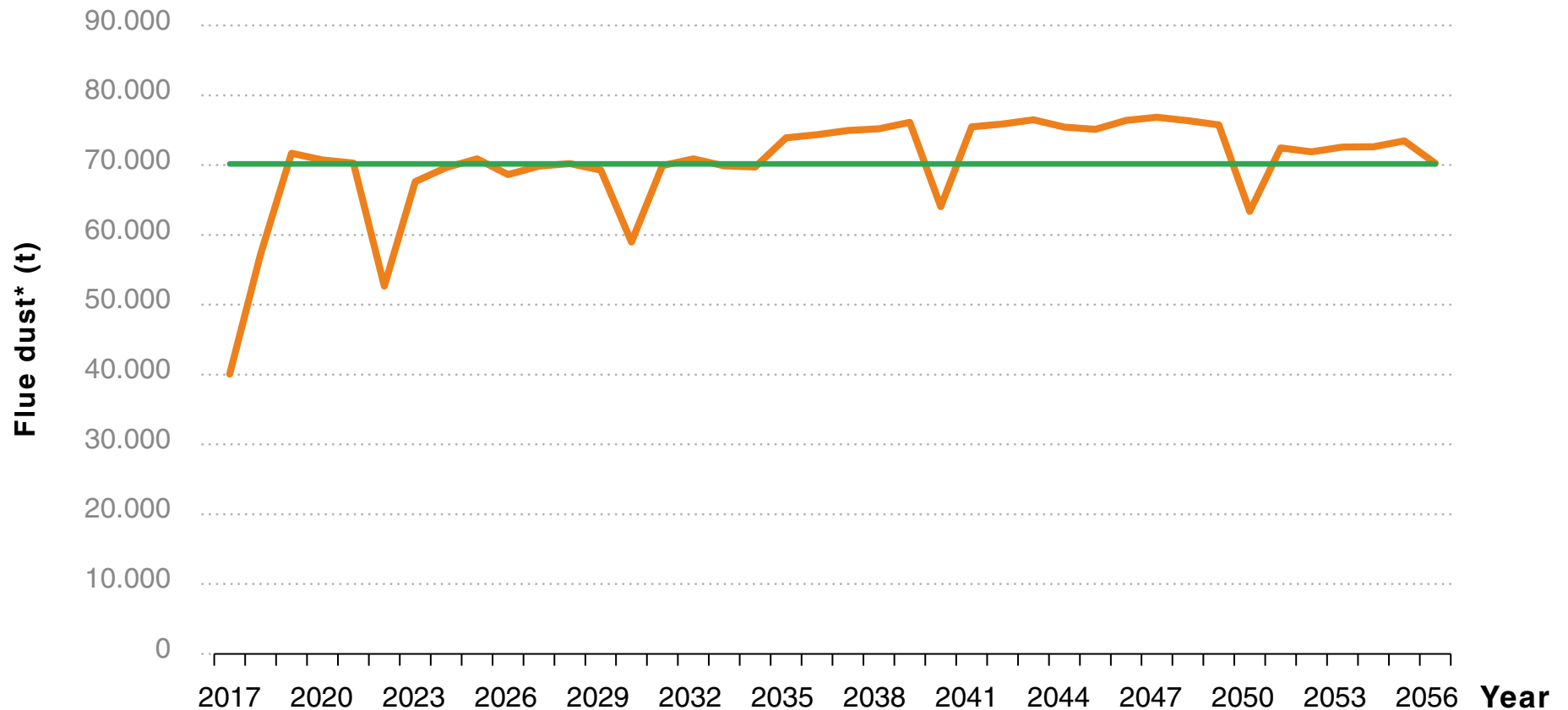
Copper smelter/refinery waste treatment



Complex Cu Concs treatment

Copper smelter/refinery waste treatment

Current and future scenarios



*Collected from off-gas treatment system, mainly from electrostatic precipitator

Copper smelter/refinery waste treatment

Current and future scenarios

Key issues for the project development

- ▶ Long-term vision, discipline and willingness to take risks.
- ▶ The need for low-cost solutions.
- ▶ Lack of availability of solutions on the market.
- ▶ Focused research. Pilot trials to elucidate unknown process variables and scale-up.
- ▶ **Brownfield project**
The need of optimizing existing facilities.

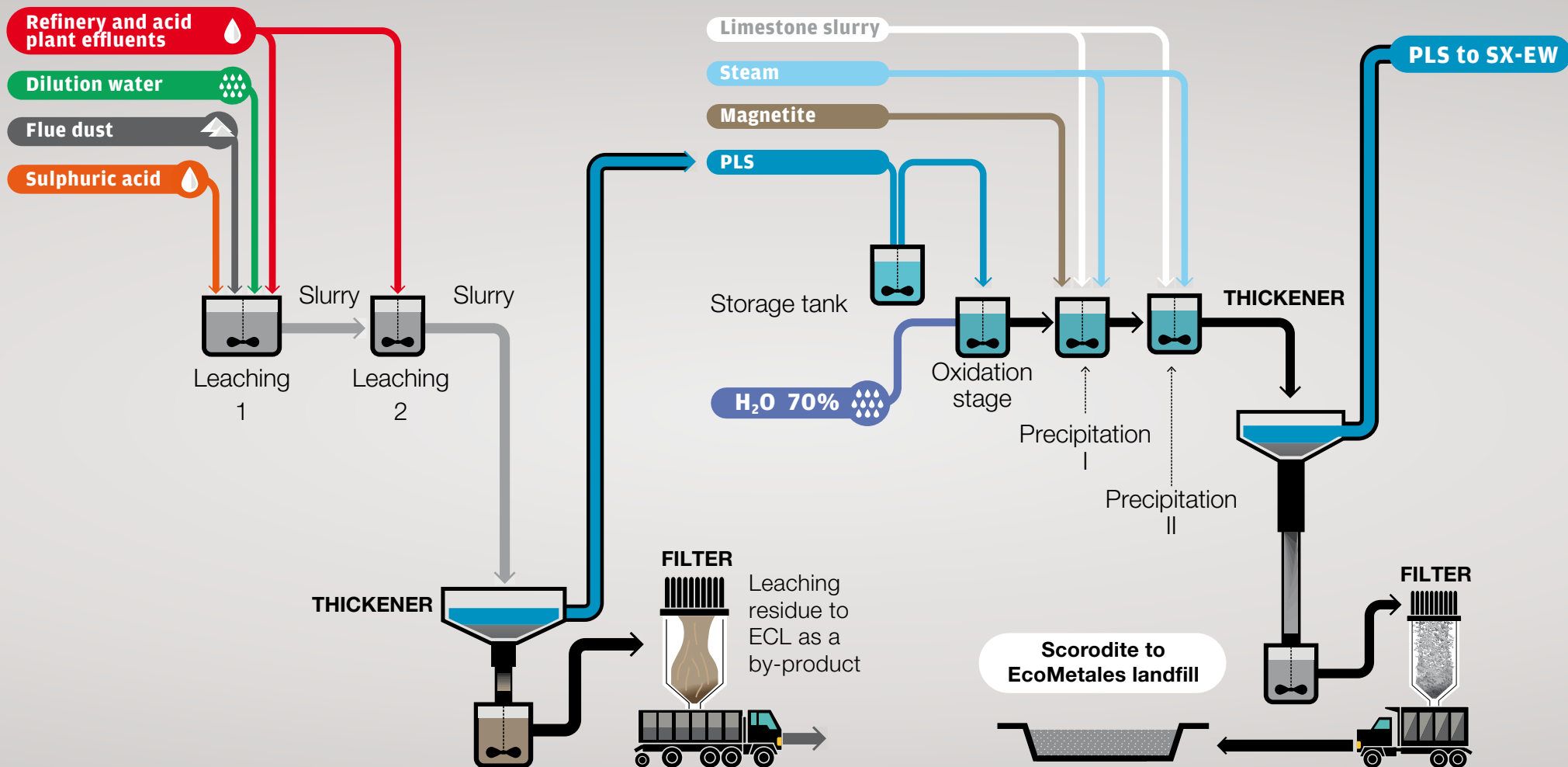
A flue dust leaching plant followed by a selective arsenic precipitation plant from existing facilities (BioCOP).

- **ECL**, 100% subsidiary of CODELCO, focused on deliver environmental solutions and value recovery for mining residues.
- **ECL** has a total workforce of about 300 people and is supported by 250 environmental permits.
- **ECL** has processed more than 400,000 tons of residues recovering 80,000 tons of copper. Since the start-up of the As stabilization plant, more than 7,500 tons of arsenic have been stabilized.



Copper smelter/refinery waste treatment

Current and future scenarios

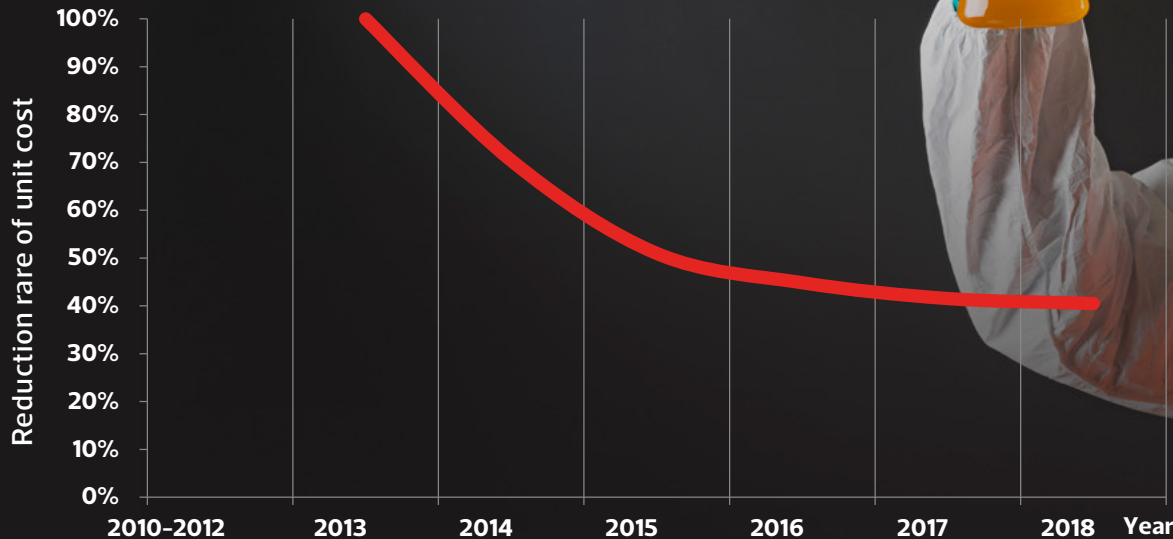


Copper smelter/refinery waste treatment

Arsenic Stabilization plant

The greatest challenge: The construction of an industrial plant based on a scientific paper

Continuous learning during the plant operation



2006	2010-2012	2013	2014	2015	2016	2017	2018
Precipitation of scorodite at laboratory scale.	PAA Project. Pilot Plant Trials. PAA Construction. PAA Start-up.	Start of operation of PAA.	Improvement of boiler use and limestone preparation stage.	Optimization of ferric solution preparation stage.	Improvement of oxidation stage.	Optimization of precipitation stage.	Improvement of automatic control.

EcoMetales developments



Copper smelter/refinery waste treatment

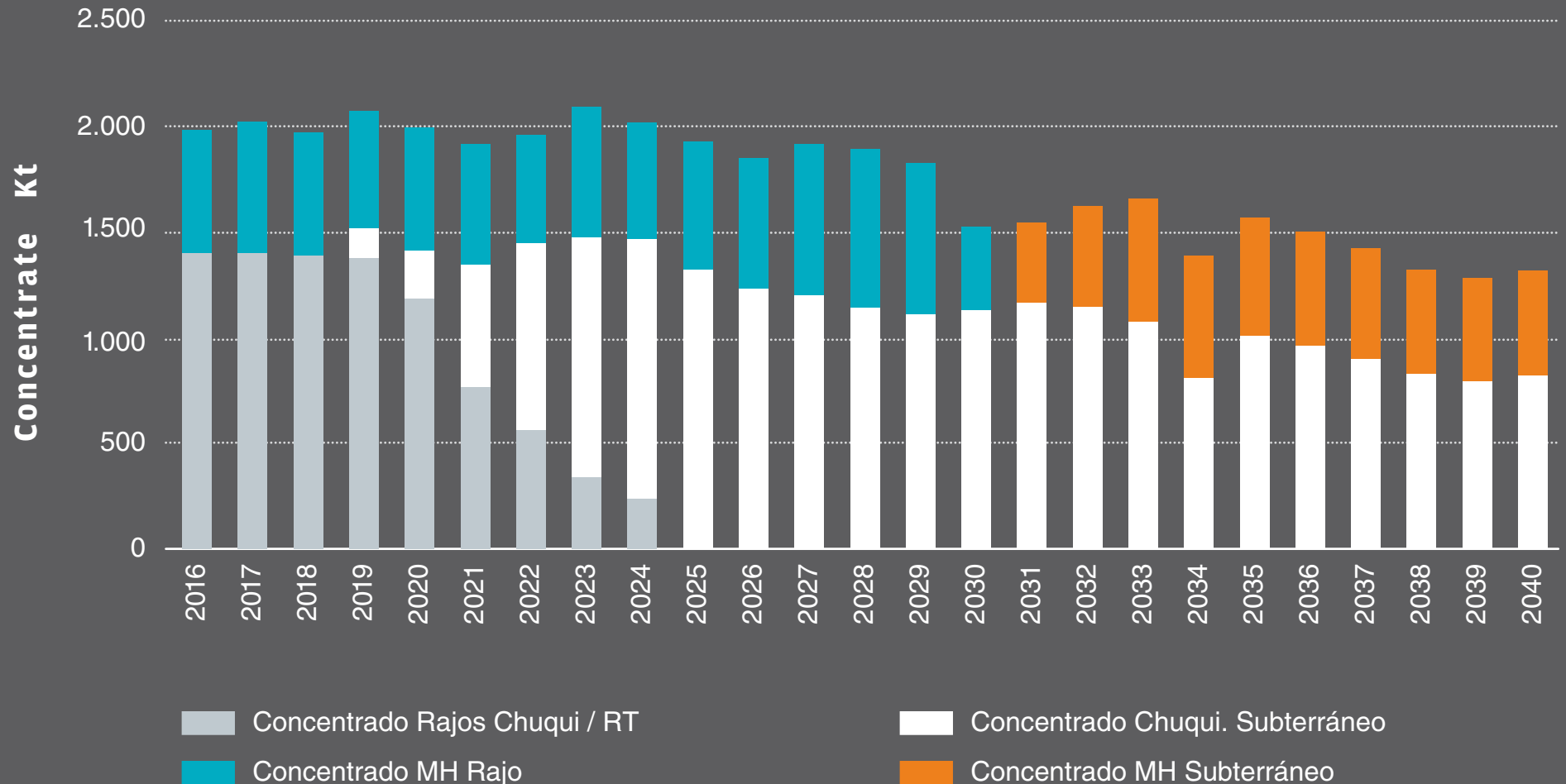


Complex Cu Concs treatment

Complex Cu Concs treatment

Current and future scenarios

Production of complex concentrate in North district*

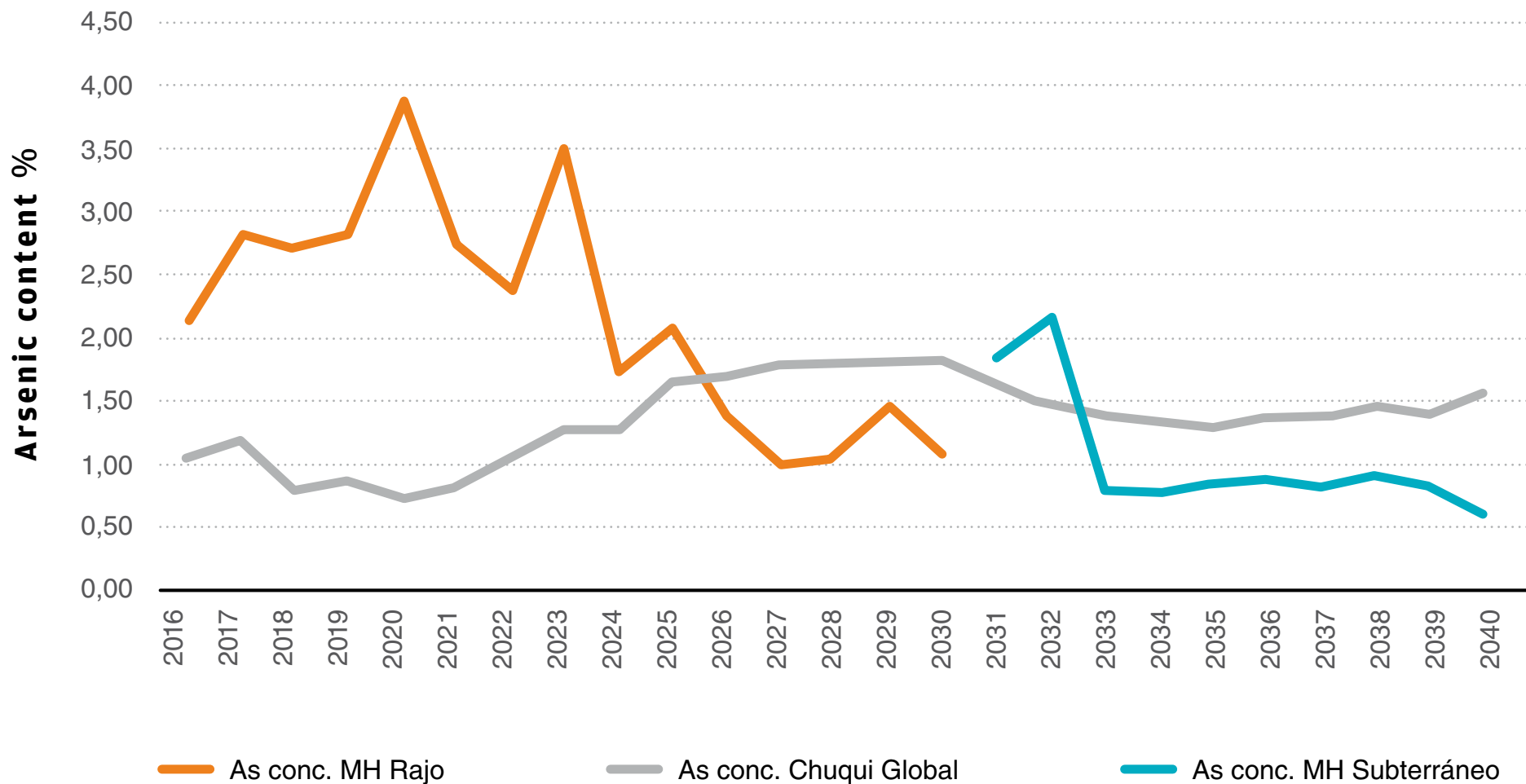


* PQ/PND 2016

Complex Cu Concs treatment

Current and future scenarios

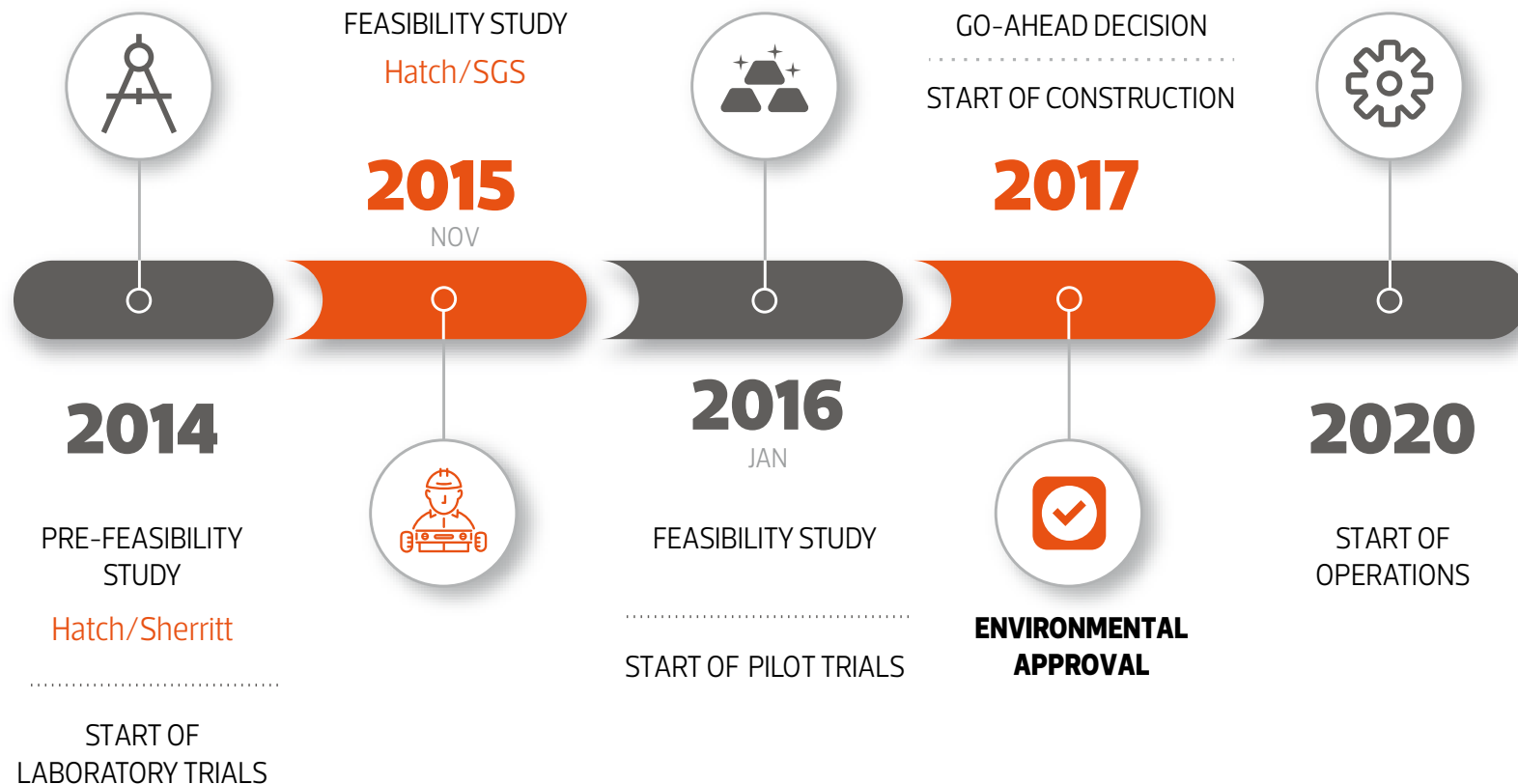
Arsenic content of complex concentrate in North district*



* PQ/PND 2016

Complex Cu Concs treatment

Complex Concentrate Leaching Process (PLCC)



**A MATURE AND ENVIRONMENT-FRIENDLY
TECHNOLOGY IN THE MINING INDUSTRY**

Complex Cu Concs treatment

Complex Concentrate Leaching Process (PLCC)

The process considers the leaching of complex copper concentrates through a high-pressure vessel. The arsenic stabilization is also performed inside the vessel.

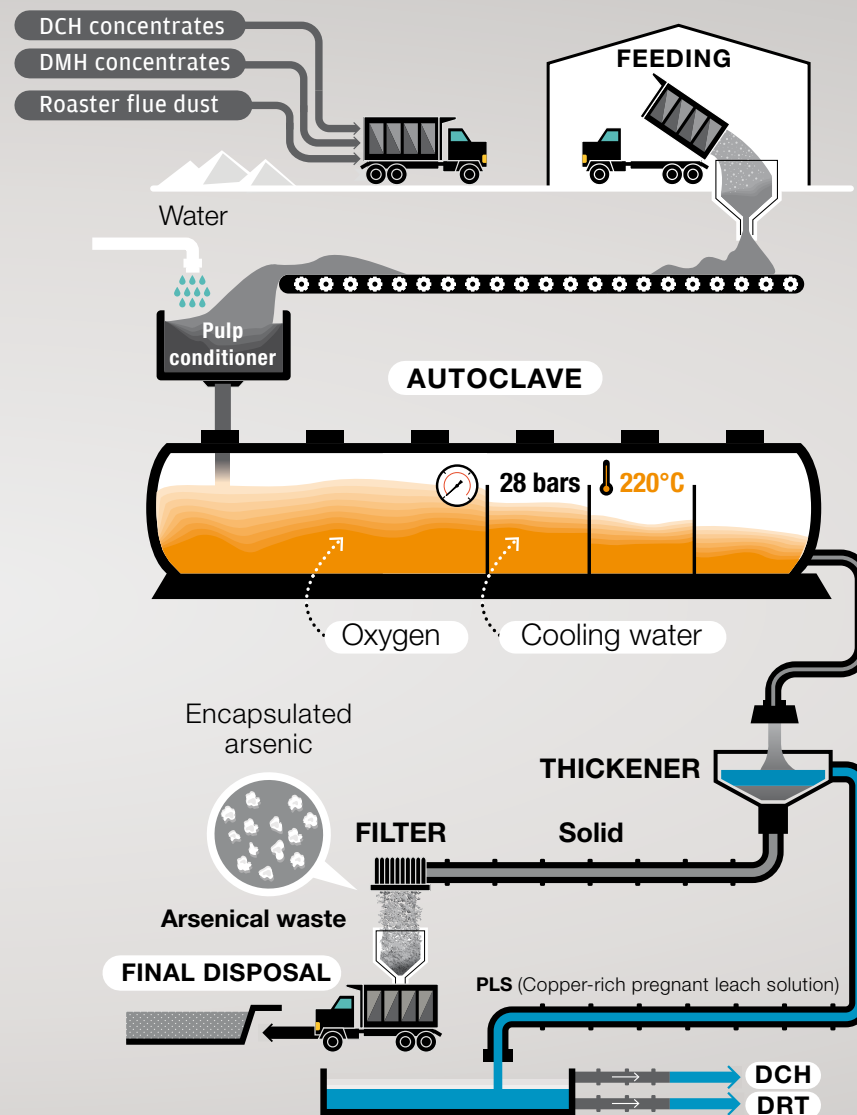
The project capacity is 200,000 t/y, the go-ahead decision should be taken during 2017.

Advantages:

- ▶ Almost zero emission
- ▶ Stable residue as scorodite
- ▶ Utilization of existing SX-EW facilities
- ▶ Low water consumption
- ▶ Competitive costs

The schedule defines the start-up for the new facilities in 2020.

Capex USD \$ 324.000.000



Complex Cu Concs treatment

Complex Concentrate Leaching Process (PLCC)



MATURE TECHNOLOGY

Processes using autoclave leaching are well known.



REGULATION

Critical complement for Codelco to be able to comply with new environmental regulation.



CLEAN PRODUCTION

Contribution of 200 ktpy of clean production to the system.



ARSENIC

First technology in the world that would close the arsenic circuit; does not emit impurities and generates stable arsenic waste.



OPTIMIZATION

Takes advantage of existing installations; SX-EW plants and leach pads to use the acid produced.

New developments

Part of the next years

- ▶ Recovery of trace elements (Ag, Bi, Sb and Ge) from the flue dust treatment.
- ▶ Tailing treatment for recovery of minor elements.
- ▶ Increase of current copper recovery of flue dust treatment plant.
- ▶ Treatment of Acid Mine Drainage (AMD).





**WE WANT TO BE A STRATEGIC PARTNER
OF THE MINING INDUSTRY**



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