Rönnskär Smelter –

A versatile and environmentally well adopted Non Ferrous Metal smelter

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Bolidens Rönnskär Smelter in 1930

- Construction began in 1928
- Environmental considerations before localisation
- Production started in 1930
<table>
<thead>
<tr>
<th>Production Levels</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>250,000 t</td>
</tr>
<tr>
<td>Lead</td>
<td>30,000 t</td>
</tr>
<tr>
<td>Zinc clinker</td>
<td>40,000 t</td>
</tr>
<tr>
<td>Silver</td>
<td>500,000 kgs</td>
</tr>
<tr>
<td>Gold</td>
<td>17,000 kgs</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>605,000 t</td>
</tr>
<tr>
<td>Liquide SO₂</td>
<td>35,000 t</td>
</tr>
</tbody>
</table>

Rönnskär, a world-class smelter, focuses on sustainable production and increased metal recycling.

It maintains high environmental standards and resource-efficiency while producing metals from concentrates and various recycled materials.
Main products – Rönnskär smelter

- Copper cathodes
- Gold
- Silver
- Lead
- Zinc Clinker (ZnO)
- Sulphur Dioxide
- Sulphuric Acid
- Granulated Slag Sand

Smelting Operations – Rönnskär
Raw material & product transports

- Aitik
- Boliden
- Rönnskär
- External conc.
  Recycled material
- Other customers
- Elektrokoppar

Rönnskär has a harbour at site

The Copper Shuttle
Rönnskär - Helsingborg

Copper contrate shuttle
Aitik mine - Rönnskär
Process & recycling
Rönnskärs Process flowsheet – compared to a conventional Cu-smelter

**Conventional Cu-smelter**

- **Dryer**
- **Fluidized Bed Roaster**
- **Electric Smelting Furnace**
- **Fuming furnace**
- **Clinker plant**
- **SO2 process gas**
- **Granulated slag**

**Secondary Raw Materials**

- **Copper Conc.**
- **Lead Conc.**

**Converter Aisle**

- **Matte**
- **Converter Aisle**
- **Blister copper**
- **Blast copper**
- **Black copper**

**Lead Refinery**

- **Anode Casting Plant**
- **Electrolytic Refinery**
- **Gold Silver Selenium**
- **Copper Copper-sulphate Nickel-sulphate**

**Sulphur Products Plant**

- **Sulphuric Acid Sulphur Dioxide**
- **Water treatment plant**
- **Cleaned water**

**Kaldo Plant**

- **Kaldo plant runs campaigns**

**Lead**

- **Lead Refinery**

**Smelting Operations – Rönnskär**

*) Kaldo plant runs campaigns
Your old computer may end up at Rönnskärs E-kaldo plant

- No. 1 electronics recycling plant
- Electronics from phones, computers etc
- 120,000 t/year total smelting capacity
- 50% of the gold and 30% of the copper from recycled materials
- Production start January 2012
WEEE *) collection rate in EU 2010

*) WEEE = Waste Electrical and Electronic Equipment
The value chain for electrical and electronic waste

- **Types of e-scrap**
  - WEEE-scrap (e.g. low-grade circuit boards)
  - Granules
  - High grade circuit board scrap
  - Alloved scrap with precious metals
  - Production waste from machinery industry
  - Telecom scrap

- Collection of e-waste from industry and households
- Inspection/Cleaning
- Partition/Fragmentation
- Separation
- E-scrap*
- BOLIDEN

- Plastic
- Glass
- Aluminium
- Iron
E-kaldo / WEEE Kaldo plant

1. Materiallager / Storage
2. Inmatning / Feeding
3. Behandling / Processing
4. Tappning från ugn / Tapping from Furnace
5. Ångpanna / Waste heat boiler
6. Gashanteringssystem
7. Transport till raffinering
Environmental permits & supervision
Rönnskär: Management systems

- Quality (ISO 9001)
- Energy (ISO 50001)
- Environment (ISO 14001)
- Safety (OHSAS 18001)
Environmental permits

Rönnskär is operated in accordance with a permit from the Swedish Land and environment court from 2014.

The permit includes overall regulations and limit values for emissions into the air and water. The degree of efficiency of cleaning equipment is regulated by guideline values.

The emission limit values are set as “bubble- limits” which gives possibilities to concentrate on the most cost-effective measures and on the largest emission points.

Emission report is sent to the authorities 1/month
Communication with authorities

- Supervising authority is County administrative board of Västerbotten
- An emission report is sent each month to the supervising agency
- A complete environmental report is sent to the authorities once per year
- Four times a year formal meeting are held with representatives from the supervising authority
- Three times a year formal meetings are held with Swedish EPA.
Emission & environmental control

- 6 environmental technicians: emission control & environmental sampling

- Sampling and calculation of emissions is performed in accordance to an approved control program

- Supervision of 37 filters (>100m²) and gas cleaning devices

- 1,300 water samples, 400 dust samples taken each year

- Continuous measurement of SO₂-emissions in 7 stacks
Emissions to air & water
4 systems for discharged water

<table>
<thead>
<tr>
<th>Type</th>
<th>Flow (m³/h)</th>
<th>Metal content</th>
<th>Pumped to</th>
<th>Pipe Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process water</td>
<td>130</td>
<td>High</td>
<td>Treatment plant</td>
<td>2 *)</td>
</tr>
<tr>
<td>Rain &amp; wash water</td>
<td>50</td>
<td>Varying</td>
<td>Treatment plant</td>
<td>20</td>
</tr>
<tr>
<td>Cooling water</td>
<td>5000</td>
<td>Low</td>
<td>The sea</td>
<td>8,5</td>
</tr>
<tr>
<td>Sewage water</td>
<td>5</td>
<td>Low</td>
<td>Sewage treatment</td>
<td>8</td>
</tr>
</tbody>
</table>

*) 1,5 km above ground
Rönnskär Water Treatment Plant

Process Water

Rain and Wash Water

Sedimentation Pond

Sodium Sulfide

Caustic Soda

Sulfuric Acid

Polymer

Supply Tank

Fluoride Precipitation Tank

Inert Sludge to Storage

Effluent Water

Reaction Tank

Thickener

Suphide sludge Recycled to Process

Hydrated Lime

Sedimentation

Effluent Water
Metal discharge Cu+Zn+Pb+As 1970-2010 to water

Emission decrease 99.9%

3.2 tonnes
Air filtration today

• 37 large textile filters (>100m²)

• Total filter area 31000 m² (= area of 4,3 football grounds)

• Volume of filtered air: 2 Mm³/h
Emissions to air 1970-2010

- Dust [ton]
- SO2 [ton]

Emission decrease
SO2 93%
Dust 98.6 %
Reducing dust emission - historical review

- 1963  ESP-filters & textile filters installed in fuming plant
- 1972  Scrubber installed in fuming plant
- 1975  Textile filters installed in lead kaldo plant
- 1979  Filtration of converter ventilation gas, step 1
- 1981  Filtration of converter ventilation gas, step 1
- 1983  Textile filter installed in fuming plant
- 1985  Restoration of ESP-filters in fuming plant, new textile filter in kaldo
- 1986  Filter for furnace gas installed at copper plant
- 1987  Textile filter installed at Precious Metals plant
- 1993  Textile filters installed for converter ventilation gas
- 1997  New scrubber & textile filter in kaldo plant
- 1999  New textile filter for converter ventilation & flash
- 2000  Belt conveyor transport system from harbor to storage
- 2001  New equipment for dioxin cleaning w. active coal in fuming plant
- 2002  New textile filter at sampling plant
- 2005  New equipment for dioxin cleaning w. active coal in clinker plant
- 2007  New ESP-filter etc installed for converter process gas
Reducing sulphur emission - historical review

- 1953  Sulphuric acid plant no 1 started production
- 1965  Sulphuric acid plant no 2 started production
- 1970  New converter off-gas system
- 1971  Sulphur dioxide plant no 1 started production
- 1973  New sulphur furnace w. Destruction plant for sulphuric acid, replaced the existing furnace
- 1977  Sulphur dioxide plant no 2, replaced no 1
- 1985  Double absorption in Sulphur dioxide plant no 2
- 1989  The old Pb furnace closed, primary lead smelting in kaldo plant
- 2000  New plant for sulphuric acid was built to take care of the increased production
Energy
Yearly energy use/recycling

Totally 1 TWh – of which 490 GWh electricity
30 GWh recovered in a steam turbine
80 GWh recovered internally as heating
29 GWh recovered by preheating the feed water
37 GWh is sold as district heating

Energy use per ton products – 50% since 1983.
Energy use/ton products 1983-2013 (including coal)

Energy use including coal/coak per ton products including sulphuric products

Rönnskär Flash Smelter Expansion
Electricity use kWh/koppar 1983-2013

Electricity use per ton copper

Rönnskär Flash Smelter Expansion
Process waste storage under ground
Underground process waste deposit

- Swedish legislation 2005 for waste material containing >0.1 % mercury
- Storage of process waste 350 meter underground
- Smelter and waste deposit at the same location – unique solution
- Permit from Swedish Environmental Supreme Court, June 27, 2014
- Start construction spring 2015, project time 5 years
Environmental studies
## Environmental monitoring – 2004-2015

<table>
<thead>
<tr>
<th>Type of study</th>
<th>YEAR</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
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<tbody>
<tr>
<td>Metals in vegetables and berries</td>
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<tr>
<td>Deposition of metals - mosses</td>
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<td>Deposition, SOx and metals (13 km)</td>
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<td>Run off, SOx and metals (13 km)</td>
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<td>SO₂ – ambient air (3 km)</td>
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<td>PM10 – ambient air (3 km)</td>
<td>x x x x x x x x x x x</td>
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<td>Pb – ambient air (3 km)</td>
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<td>Water chemistry (lake, 5 km)</td>
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<td>Fish population (lake, 5 km)</td>
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<td>Metals in fish (lake, 5 km)</td>
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<td>Metals in sediment (lake, 5 km)</td>
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<tr>
<td>Metals in molluscs (sea)</td>
<td>x</td>
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<tr>
<td>Bentic fauna (sea)</td>
<td>x x x x x x x x x x x</td>
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<tr>
<td>Metals in fish (sea)</td>
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<tr>
<td>Metals in sediment (sea)</td>
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<td>x</td>
</tr>
</tbody>
</table>
Deposition of lead in Sweden 1975 - 2000

Source: IVL Swedish Environmental Research Institute
Sulphur deposition, Sweden 2000-2005

2000-2001

2004-2005

Source: IVL  www.ivl.se
## SO₂ in ambient air

<table>
<thead>
<tr>
<th>Swedish limit values (µg/m³)</th>
<th>¹98-perc mean values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 h</td>
</tr>
<tr>
<td></td>
<td>200</td>
</tr>
</tbody>
</table>

¹may be exceeded 175 h/year

### Measurements made close to Rönnskärsverken (µg/m³)

<table>
<thead>
<tr>
<th>Year</th>
<th>max 1 h mean for whole period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>46</td>
</tr>
<tr>
<td>1998</td>
<td>²242</td>
</tr>
<tr>
<td>1999</td>
<td>²225</td>
</tr>
<tr>
<td>2000</td>
<td>175</td>
</tr>
<tr>
<td>2001</td>
<td>170</td>
</tr>
<tr>
<td>2002</td>
<td>120</td>
</tr>
</tbody>
</table>

²not exceeding the 98-percentile limit
## Lead in ambient air 3 kms from Rönnskär

### Swedish air quality standard

Lead in ambient air,
1 year average

<table>
<thead>
<tr>
<th>Year</th>
<th>Lead in μg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>0.029</td>
</tr>
<tr>
<td>2000</td>
<td>0.016</td>
</tr>
<tr>
<td>2001</td>
<td>0.044</td>
</tr>
<tr>
<td>2002</td>
<td>0.037</td>
</tr>
<tr>
<td>2003</td>
<td>0.040</td>
</tr>
<tr>
<td>2004</td>
<td>0.047</td>
</tr>
</tbody>
</table>
Exposition of Pb to children living in the vicinity of Rönnskär

Lead in blood

µg/l blood

- 1991
- 2001
- S. Sweden
- Stockholm

Datumområde
Exposition of heavy metals to pregnant women in the vicinity of the plant compared to non exposed women.

Test group, geographic data

Assays
Lead and cadmium in blood, Arsenic in urine, Mercury in hair

Results
Low concentrations of Pb, Cd and As
No difference in the smelter-area levels compared to reference group
Higher Hg at reference location (Holmsund) compared to Skelleftehamn

Pregnancy outcome
No difference close to the smelter compared to the rest of the community.

Lung cancer
No elevated risks for lung cancer in the area.
Mercury (Hg) assay in perch

Average Mercury (As) assay in perch (muscle) from Rönnskär, and reference locations Byskefjärden and Bergsbydammen 2003 (±95 % konf.interval).
Arising from Rönnskär, and reference locations Byskefjärden and Bergsbydammen 2003 (±95 % konf.interval).
Mercury (Hg) assay in whitefish 2004

Sik - kvicksilver i muskel (inkl 95%-konf.intervall)

Limit: 0,5 mg/kg våtvikt

Rönnskär

Kågnäsudden

2004