Our Approach

At Kennecott Utah Copper, sustainable development is integral to our success as a producer of copper cathode, molybdenum, gold, silver, and sulfuric acid, and to the social and financial investment we have made in our stakeholders and surrounding communities.

Consistent with our sustainable development principles, safety remains one of our core values. We are committed to continually improving health and safety performance in our operations. Currently, our safety record is almost three times better than the industry average, and we aim to continually improve this record with the ultimate goal of achieving a sustained zero incident workplace.

This Copper Environmental Profile is intended to summarize the results of the Life Cycle Assessment of the copper cathode originating from Kennecott's Bingham Canyon Mine. A more detailed profile can also be obtained upon request to help our customers better understand the environmental impacts of their products or services when conducting their own life cycle studies.

What is Copper?

Copper has been used for more than 10,000 years. First used to create decorative shapes, bowls and ornaments, copper is now playing a vital role in many branches of modern society and technology. Copper’s ductility led to its use in contemporary plumbing and heating systems. Its corrosion resistance makes it an excellent roofing material for buildings, and its electrical conductivity remains the key to modern power generation and distribution. Today, more than 15 million tons (13.6 million tonnes) of copper are extracted from geologic resources annually worldwide.

According to the Copper Development Association, copper is 100% recyclable, and retains its quality (its chemical or physical properties) when recycled. To date, it is one of the most recycled metals. In the United States, nearly as much copper is recovered from recycled material as is derived from newly mined ore.

In addition, copper has natural anti-microbial properties, and the US Environmental Protection Agency has registered 275 copper alloys as antimicrobial materials that kill certain bacteria, including staphylococcus aureus. Copper surfaces remain effective in killing more than 99.9% of several bacteria known to be human pathogens within two hours.
How is it Produced?

At Kennecott Utah Copper, the ore is extracted from the Bingham Canyon Mine by blasting. Electric shovels load trucks with the broken ore. The rock that does not contain economic mineral grades is considered waste rock, and is responsibly disposed of in a designated waste rock disposal area. This ore is then moved to a crusher in the pit, which breaks the rock into pieces less than 10 inches (25 cm) in diameter. The crushed ore then travels five miles (8 km) by conveyor belt to the concentrator. In the concentrator, the ore is mixed with an aqueous solution and ground into a fine powder in a two-step milling process. The ore powder is then mixed with water, chemicals, and air in flotation cells. This process causes the copper-bearing minerals to stick to air bubbles in the cells. When the bubbles float off the top, they’re collected as a liquid concentrate (28% copper). Molybdenum is collected and separated out at this stage. The remaining particles sink to the bottom to become “Tailings.”

The concentrate is transported approximately 17 miles (27 km) to Kennecott’s smelter, where it’s dried in a rotating dryer, then sent into a flash smelting furnace. In the furnace the dried concentrate is heated to a molten state and separated into three products: gases – that contain sulfur; slag – mostly silica and iron; and, copper matte – which is 70% copper.

After cooling, the copper matte is ground and fed into a furnace where most of the remaining impurities are removed. This produces a molten liquid (“blister”) that is 98% copper. The blister is then refined in another furnace to 99.6% purity and then cast into 700 lb (318 kg) anodes.

The anodes are moved to the refinery where they are lowered into an acid solution, interleaved with stainless steel cathodes. For 10 days an electric current is sent between the anode and the cathode, causing the copper ions to migrate from the anode to the cathode. Other impurities, including gold and silver, drop off into the bottom of the tank where they are collected for further processing. The electrolytic process forms a plate of 99.99% pure copper. One anode will produce two cathodes, each weighing about 280 pounds (127 kg). These copper cathodes are Kennecott’s finished product. They are stripped from the stainless steel, strapped together in 5,500-pound (2.5-tonne) bundles, loaded onto railcars, and shipped to our customers.

Life Cycle Assessment

Life Cycle Assessment (LCA) studies involve the collection, assessment and interpretation of data from an environmental perspective over a product’s life cycle (production, use, and end-of-life). Studies can evaluate:

- the entire product life cycle, often referred to as cradle-to-grave or cradle-to-cradle studies, or
- parts of a product life cycle, referred to as cradle-to-gate or gate-to-gate studies.

Figure 1

GOAL AND SCOPE
DEFINITION
INTERPRETATION
LIFE CYCLE INVENTORY (LCI)
LIFE CYCLE IMPACT ASSESSMENT (LCIA)

Inputs
Energy – Consumables – Raw Materials – (ore, water, air)

MINING
* Drilling
* Blasting
* Loading
CRUSHING
CONCENTRATING
* Grinding
* Flotation
SMELTING
* Drying
* Furnaces
* Anode Casting
REFINING
* Cathode Production
Other Outputs
Air Emissions
Water Tailings

Molybdenum
Sulfide to Roasters
Sulfuric Acid
to Customers
Copper Cathodes or Precious Metals to Customers

Figure 2 – Process Flow – Mining to Refining
Copper Environmental Profile

Life Cycle Assessment

Goal and Scope
The Kennecott LCA project included a complete cradle to gate LCA study for copper cathode, gold, silver, molybdenum oxide and sulfuric acid produced by the mining operation. The methodology used was consistent with ISO 14040 series LCA standards, as shown at a macro level in Figure 1.2

LCA provides Kennecott with a systematic, comprehensive method to evaluate and communicate the environmental impacts of its products and processes. This approach helps the company ensure that a change made in one of its processes will not result in an equal or greater increase elsewhere, including the upstream supply chain. LCA also provides Kennecott with a way to benchmark and improve its operational performance from a sustainable development perspective. Finally, LCA provides Kennecott with a broader view of how its products impact the world, both positively and negatively.

Specifically, the analysis examined how the production of copper, gold, silver, molybdenum and sulfuric acid impacts environmental indicators, such as smog, acid rain, energy, and greenhouse gases from a cradle to gate perspective. Data gathered for the study represents operations at Kennecott’s facilities during the 2006 calendar year. The study was undertaken for internal use by Kennecott and the absolute numbers are only communicated in a confidential, aggregated manner to select customers and LCA database providers. The functional units for the study were 1000 kg each of copper, molybdenum and sulfuric acid, and 1 kg each of gold and silver.

Life Cycle Inventory: LCI
Life cycle inventory (LCI) is a key step in the LCA process. The LCI catalogs all the environmental inputs and outputs of a product system. Data may be collected first-hand from measurements and estimates of key activities, or the data will be based on information drawn from existing LCA databases. At Kennecott, the majority of inventory data was collected on-site and modeled using GaBi 4.0™LCA software. Data included or excluded from the study was dependent on the system boundaries identified during the goal and scope definition. The LCA system boundaries for the study are described in Table 1 and Figure 3.

An allocation based on mass was performed in the concentrator model in order to divide the burden in the system to that point between molybdenum and copper concentrate. The copper concentrate is eventually refined into copper, gold and silver. The inputs and outputs of the concentrator as well as all preceding processes (back to earth) were allocated proportionally based on the mass of each product leaving the unit process. For example, if a product accounts for 20% of the total mass of all the products, 20% of the inputs and outputs are assigned to it.

An additional allocation had to be performed in order to divide burden among the various co-products produced in the refinery. These products include copper, gold and silver. Because of the high value of the precious metals and the high mass of copper produced, it was decided a market value allocation would best represent the burden of 1000 kg of copper. Thus, a market value/revenue based allocation was performed in the refinery model in order to determine the overall burden of the system to be allocated to copper. A sensitivity analysis was performed on this allocation, which demonstrated the validity of the method selected.

A critical review, or independent verification, was not carried out for this study given the goal definition outlined previously and the requirements of ISO 14040. However, internal reviews were carried out by project team members at both Kennecott and PE Americas. The PE Americas reviewers included Johannes Gediga and Marc Binder, internationally recognized experts in the field of LCA.

Table 1 – LCA SYSTEM BOUNDARY

<table>
<thead>
<tr>
<th>INCLUDED</th>
<th>EXCLUDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ore and overburden mining</td>
<td>• Capital equipment and maintenance, with the exception of mining equipment</td>
</tr>
<tr>
<td>• Maintenance and operation of mining equipment</td>
<td></td>
</tr>
<tr>
<td>• Internal transportation of materials</td>
<td></td>
</tr>
<tr>
<td>• Extraction, beneficiation and processing of materials</td>
<td></td>
</tr>
<tr>
<td>• Manufacture of raw and processing materials*</td>
<td>• Overhead (heating, lighting) of off-site administrative facilities</td>
</tr>
<tr>
<td>• Transportation of raw and processing materials to Kennecott</td>
<td>• Transportation of finished product from the Kennecott site</td>
</tr>
<tr>
<td>• Off-site molybdenum roasting process**</td>
<td></td>
</tr>
<tr>
<td>• Manufacture and transport of packaging materials for sulfuric acid</td>
<td></td>
</tr>
<tr>
<td>• On and off-site power generation</td>
<td></td>
</tr>
<tr>
<td>• On and off-site waste management and disposal</td>
<td></td>
</tr>
<tr>
<td>• Overhead (heating, lighting) of on-site administrative and manufacturing facilities</td>
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</tbody>
</table>

*LCI data was included for process materials from the GaBi 4 Software database.
**Molybdenum roasting data was provided by the IMoA (International Molybdenum Association), as documented in the February 2008 IMoA report
"Life Cycle Inventory of Metallurgical Molybdenum Products: Update Study Final Report."

Figure 3 – LCA System Boundary

<table>
<thead>
<tr>
<th>ENERGY SOURCES</th>
<th>PROCESS MATERIALS</th>
<th>RAW MATERIALS</th>
<th>AIR EMISSIONS</th>
<th>WATER EMISSIONS</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>Steel Drill Bits</td>
<td>Mine Rock</td>
<td>Carbon Dioxide</td>
<td>Iron</td>
<td>Water Discharge</td>
</tr>
<tr>
<td>Diesel</td>
<td>Steel Balls</td>
<td></td>
<td>Nitrogen Oxides</td>
<td>Strontium</td>
<td>Waste Rock</td>
</tr>
<tr>
<td>Gasoline</td>
<td>Rubber Tires</td>
<td></td>
<td>Sulfur Dioxide</td>
<td>Manganese</td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>Lime</td>
<td></td>
<td>Particulate Matter</td>
<td>Lead</td>
<td></td>
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<tr>
<td></td>
<td>Limestone</td>
<td></td>
<td>Others</td>
<td>Others</td>
<td></td>
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<tr>
<td></td>
<td>Blasting Materials</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Sodium Hydroxide</td>
<td></td>
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<tr>
<td></td>
<td>Sodium Hydrosulfide</td>
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<tr>
<td></td>
<td>Nitrogen</td>
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<td></td>
<td>Engine Oil</td>
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<td></td>
<td>Sodium Silicate</td>
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<td></td>
<td>Oxygen</td>
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<td></td>
<td>Flocculant</td>
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<tr>
<td></td>
<td>Ammonium Nitrate</td>
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<tr>
<td></td>
<td>Others</td>
<td></td>
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</tr>
</tbody>
</table>

MINING

CONCENTRATING

SMELTING

TAILINGS IMPOUNDMENT

REFINING

Copper Cathode
Life Cycle Impact Assessment

Following the LCI, a life cycle impact assessment (LCIA) was completed to help Kennecott determine which process or processes have the greatest adverse environmental impact. LCIA helps Kennecott pinpoint opportunities for improvement within its operations.

Estimates for potential environmental impacts are organized under four main impact categories (shown below in Table 2). These impact categories were selected based on:

- the geographical location of Kennecott’s operations, or
- issues Kennecott currently addresses either through its internal reporting or its Environmental Management System.

### TABLE 2 – LCIA CATEGORIES

<table>
<thead>
<tr>
<th>IMPACT CATEGORY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Energy Demand</td>
<td>A measure of the total amount of primary energy extracted from the earth, including petroleum, hydropower and other sources, taking into account the efficiency of electric power and heating processes.</td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td>A measure of greenhouse gas emissions, such as CO₂ and methane, calculated using the IPCC 2001 Global Warming Potential Index (GWP100).</td>
</tr>
<tr>
<td>Acidification Potential</td>
<td>A measure of emissions to air known to contribute to atmospheric acid deposition (acid rain).</td>
</tr>
<tr>
<td>Photochemical Oxidant Creation Potential</td>
<td>A measure of emissions of precursors that contribute to low level smog, produced by the reaction of nitrogen potential oxides and VOCs under the influence of UV light.</td>
</tr>
</tbody>
</table>

### Primary Energy Demand (PED)

In copper production, the concentrator, followed by the mine and smelter, dominate energy use.
**Global Warming Potential (GWP)**

The processes contributing the most to Global Warming Potential are the concentrator, mining, and the smelter. The GWP breakdown for the concentrator is almost identical to the PED breakdown on the previous page. As a result, the breakdown for the next most significant contributor, the mining process, is shown above. The greatest contributor to GWP is diesel combustion resulting from hauling overburden and ore at the mine.

**Acidification Potential (AP)**

The majority of Acidification Potential emissions are generated by the concentrator. The majority of these emissions result from the production of electricity from on-site and off-site sources.

**Photochemical Oxidant Creation Potential (POCP)**

The concentrator is the largest source of POCP. Because the breakdown for POCP at the concentrator is similar to the breakdown for AP, the sources for the next most significant contributor, mining, are shown. Diesel fuel combustion (and the resulting nitrogen oxide emissions) is the greatest source of POCP at the mine. These emissions are generated during diesel combustion from heavy mobile equipment used to haul overburden and ore.
Disclaimer: The data reported in this Copper Environmental Profile includes off-site impacts as appropriate for LCA. Consequently, the inclusion of such aspects must be considered when comparing the information included in this Profile to other reported data from Kennecott’s operations that do not include off-site life cycle impacts. For more information, please see Table 1 – LCA SYSTEM BOUNDARY on page 5 of this Profile.

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