

Cu

Copper Alliance™



## Environmental facts about copper in outdoor designs

Sustainability and beauty with copper solutions



Copper has a long tradition as building, construction and design material. It has commonly been used for centuries in roofs and decades in various external structures e.g. facades, claddings, gutters, and down pipes. In recent years, interest in using copper – the green metal – because of its favorable environmental characteristics has grown amongst the architects and planners.

With the growing use of metals in outdoor designs, some concerns about emissions of metals and their interaction with the environment have been raised. With regard to these concerns the European copper industry has performed a voluntary risk assessment of copper and its potential effects on health and environment. Several other research efforts have also been performed in relation to sustainability and environment. All results show that copper is a sustainable, long lasting material with no harmful effects on the environment. This leaflet summarizes the latest research results.

#### **Copper and its winning characteristics**

1. Long life-time – often a life-time of 200 years, but there are some copper roofs which are about 350 years old
2. Formability – it is easy to form copper into façades and roof structures
3. Maintenance – a copper roof or façade needs no special maintenance
4. Temperature and weather resistant, which means a very long service life. Copper is ideal for cold climate conditions and places where temperature variations are high as it does not break when worked/formed.
5. Natural beauty and variable surfaces – available in many shades from natural orange-red to brown and green as well as lively surfaces.
6. Durable and fire safe
7. Full recyclability and high recycling rate – saves natural resources and maintains its value.
8. Copper is essential for all life.
9. Has low embedded CO<sub>2</sub>.

#### **Historical evidences**

Parthenon, Acropolis of Athens, Greece (447 B.C. – 432 B.C.). Scientist believe that the roof of Parthenon was of small copper sheets and that the doors of the western cella were strengthened with bronze bars and the eastern doors were probably hollow bronze.

Sculptures of bronze dating back to 400 B.C.- 300 B.C. can still be seen in European museums e.g. the Greek Horses of San Marco's Basilica in Venice, Italy.

In some parts of Europe copper was considered one of the best roofing materials as early as 16th century. John III of Sweden (1568-1592) wanted to have a copper roof on his palace "Three Crowns" in Stockholm.



### Essential for life

Copper is essential for all forms of life. It exists naturally in environment being essential for the metabolism of animals, plants and humans. It is regulated by homeostasis and does not accumulate in food chain. In agriculture it is widely used to improve soil quality and as food supplement to keep cattle healthy. Copper is a natural essential element, which should not be mistaken with manmade chemicals or toxic heavy metals, which can accumulate in humans, sea life, and plants. Copper is heavy by its density (8,94 g/cm<sup>3</sup>), but this has nothing to do with hazard or environmental properties.

### Bioavailability

In nature, copper appears in the form of solid mineral and as a trace element in plants, organisms and water. It is primarily the dissolved ionic form that is available to be absorbed by humans, animals and plants. Absorption, storage and excretion of copper are completely

normal phenomena in the natural cycle. Being released to nature in ion form copper will be quickly bound to particles or minerals which are no longer bioavailable.

### Runoff and patina

Copper sheet exposed to atmospheric conditions gradually forms a surface layer of corrosion, known as the patina. The prevailing concentrations of air pollution and the environmental conditions essentially determine the composition and protective properties of the patina. Owing to the environmental interaction, a small part of the patina dissolves and is released from the copper surface during precipitation. This is called the runoff. The sulfur dioxide in the atmosphere is one major factor that influences the corrosion process. A substantial decline of the sulfur dioxide in the air since the 1980's has resulted in a substantial decrease in the runoff.

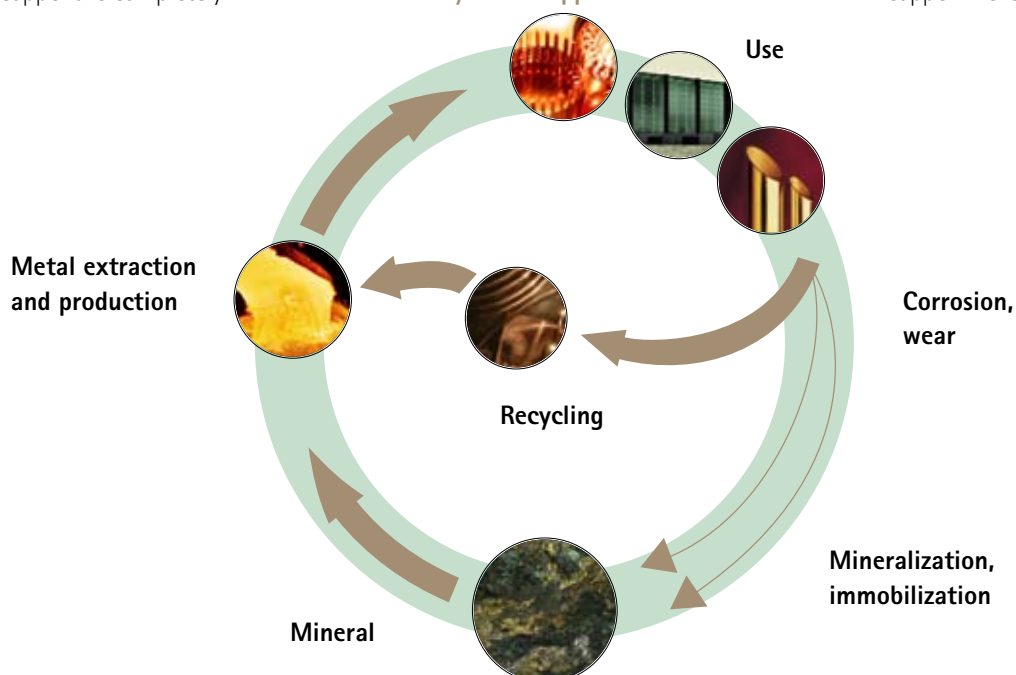
### Entries in the environment

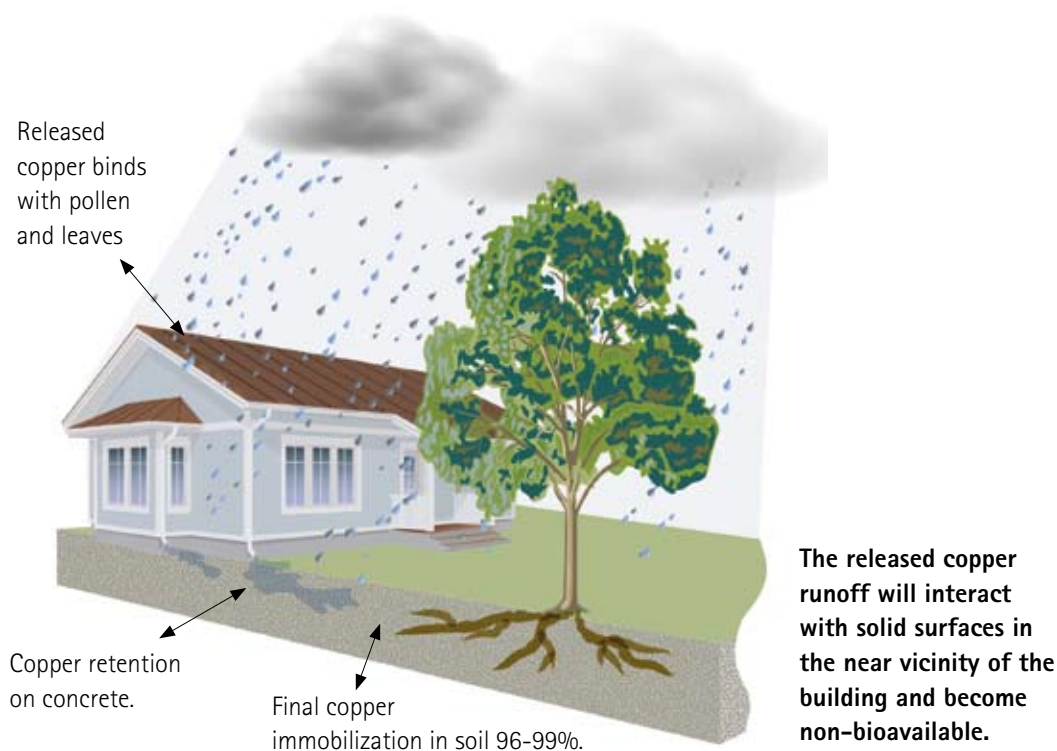
The copper voluntary risk assessment has shown that only 1% of the overall amount of copper that enters into the environment from anthropogenic sources can be attributed to copper from outdoor designs. If the natural seasonal process (falling of leaves) is taken into account this portion reduces even less. Research also shows that the bioavailable portion of copper in the runoff is quickly and considerably reduced and stays in the immediate vicinity of the roof.

### Life cycle of copper

The copper industry has compiled up-to-date life cycle data for its products. Production data has been collected from across the copper industry in co-operation with recognised life cycle consultants using standardized methodology. The long life and recyclability of copper products have a positive impact on their life cycle, from cradle to grave. For more information please visit [www.copper-life-cycle.org](http://www.copper-life-cycle.org).

### Natural cycle of copper





## Solutions to predict and reduce runoff

Research activities at the Royal Institute of Technology/Division of Corrosion Science of Sweden have generated a comprehensive picture of the runoff process. By combining laboratory and field exposures based on a multi-analytical and cross-disciplinary research approach, a runoff rate model has been developed to enable predictions of runoff rates for specific designs or areas. The model considers the importance of the annual concentration of sulfur dioxide in the air, the average rain pH, the annual rainfall quantity, and the degree of surface inclination on the runoff rate process.

The model is available at [www.corrosionscience.se/runoff/](http://www.corrosionscience.se/runoff/). You can enter your own parameters on the model and get the runoff rates of your design.

It is important to notice that the corrosion process and the runoff process are governed by different mechanisms. The corrosion process is mainly of an electrochemical nature and the process takes place at the interface between the bulk metal and the corrosion product. The runoff process, on the other hand, is primarily of a chemical nature and occurs at the interface between the corrosion product and the atmosphere.

Research activities also involve studies on changes in chemical speciation, bioavailability and fate of released copper during environmental interaction with solid surfaces such as concrete pavement, soil and limestone in the near vicinity of buildings. At the site of immediate release, copper is in a bioavailable

form. However, it immediately starts to interact with inorganic and organic surfaces in the drainage system and bioavailable fraction is significantly reduced before entering the environment.

### Corrosion resistant alloys

In order to offer products that generate even less runoff than pure copper sheet the copper industry is investing in the development of special copper alloys. With some alloying elements the excellent properties and aesthetic of copper are maintained, yet the products are even more resistant to corrosion.

### References:

I. Odnevall Wallinder, S. Bertling, X. Zhang and C.Leygraf: Predictive models of copper runoff from external structures, *J.Environ.Monitor.* 2004, 6, 704-712

S. Göbbling-Reisemann, L. Tikana, H. Sievers, and A. Klassert, *Life Cycle Methodology for Copper - Allocation and Recycling Approaches*, COM2007, Toronto.