Regional resource management of copper

A methodical contribution to the exploration of urban stocks

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Motivation

Increasing standard of living generally involves growing material consumption, resulting in large material flows and accumulating anthropogenic stocks (consumption and landfills). Some material stocks in consumption exceed already the reserves in the primary ore deposits. This is the case for copper (Zeltner et al., 1999).

This study shows a method for the exploration of trace element deposits in urban areas exemplified on copper in Switzerland, complementary to the main elements covered by the higher-ranking project *ARK04* (Lichtensteiger et al., 2004). The main focus is on the immovables, i. e. the buildings and the infrastructure, whereas the stock in the buildings is investigated more detailed due to its challenging complex structure.

Selected approach for buildings

The building stock is investigated separately for the four building types *one-family building*, *multi-family building*, *service building* and *production building*. Each building type is represented by a so-called *ARK house* with average size and material content for it's building type class (Fig. 1).

The copper content for the 4 *ARK houses* was determined by the investigation of selected buildings, which show typical or extreme copper use for the examined functional range. For building size standardisation, the roofage and the total floor area were used as reference faces.

The copper contents are extrapolated to the sub-stocks by means of statistical *ARK04* project data.

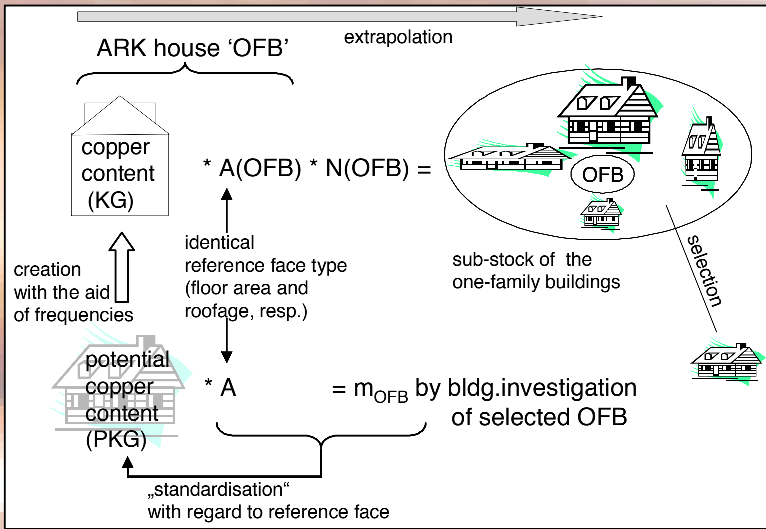

Fig. 1 Procedure scheme for the derivation of the ARK house characteristics and the extrapolation of the building stock by means of the example 'sub-stock of one-family buildings' (OFB).

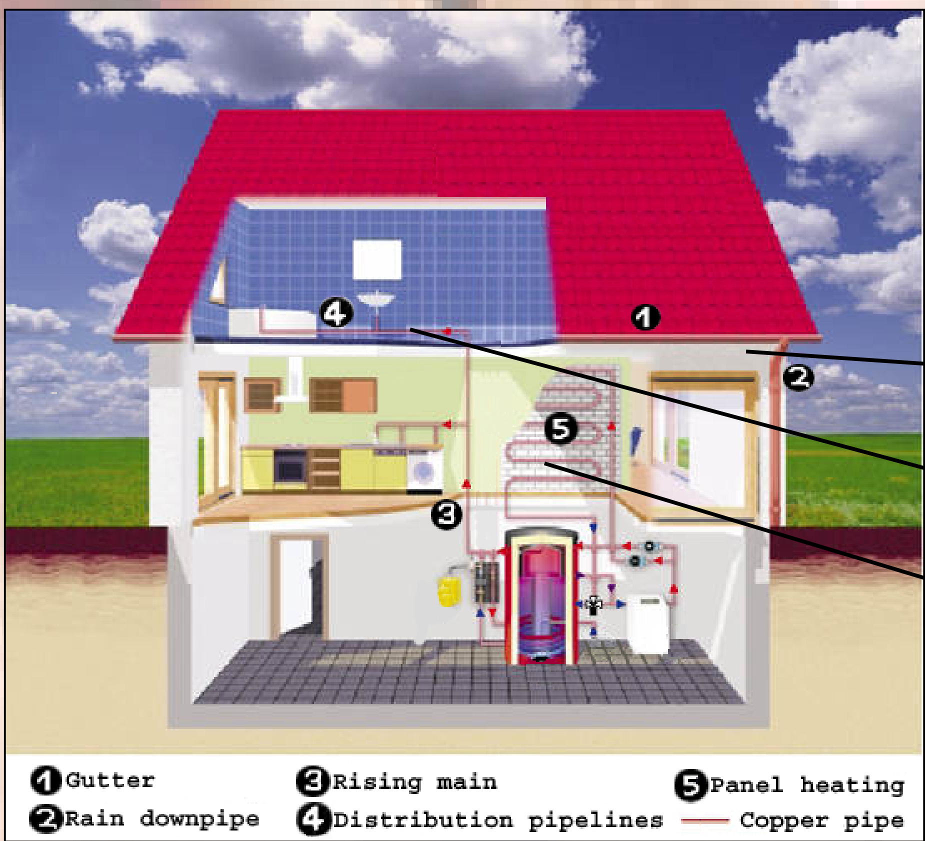

Fig. 2 Schematic building diagram showing the component parts in the cladding and in the domestic technique.

Application of copper in buildings

Due to it's physical and chemical properties (plasticity, corrosion resistance, thermal und electrical conductivity), copper and it's alloys are commonly used metals in building construction both for the cladding and for the domestic technique (Fig. 2).

The heterogeneous intensity of copper use requires a diversified approach by segmentation of the selected 5 functional ranges into different product groups (Fig. 3). The products applied within the functional ranges are unitised into 11 'product groups'. At this level the decisions on the executions (for/against Cu) are made independently from each other.

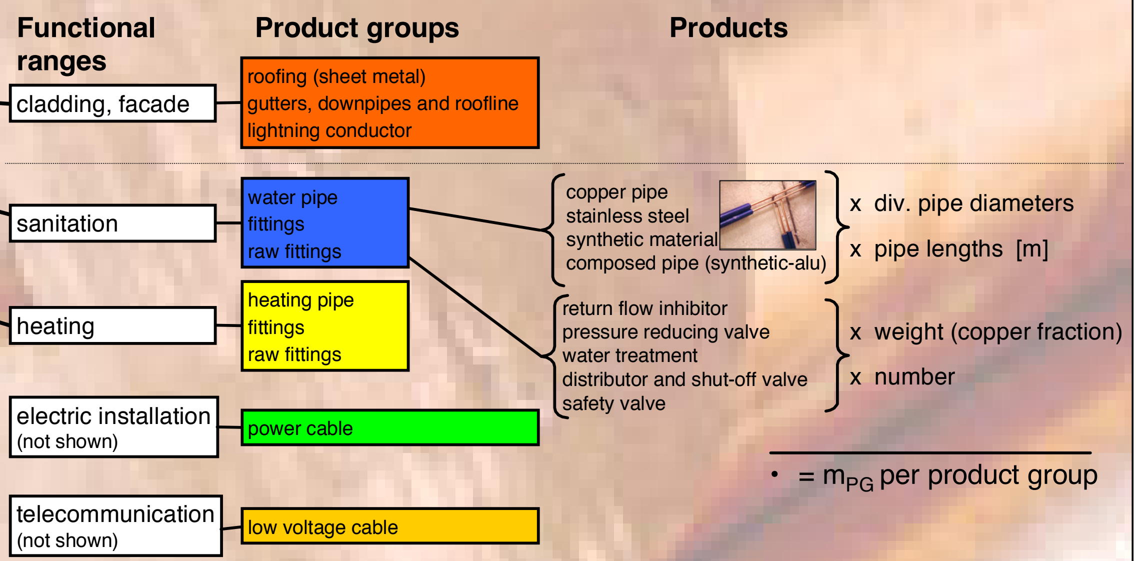

Fig. 3 Copper and alloy component parts of a building grouped per functional ranges. The different products are arranged together in product groups (shown for sanitation).

Method

The building investigation includes measurements of (A) the installation density and (B) specific copper masses for each product group as well as the building size (reference faces).

As the investigated buildings differ from each other and from the *ARK house*, the measurements can be abstracted to *potential copper contents* (PKG) per product group (Box 1). The PKG is the basis that allows to derive the *ARK house* copper content (KG) by means of the frequencies of cupreous product use (Box 2).

BOX 1 PKG of selected buildings

$$PKG_{PG} = \frac{m_{PG}}{'reference \quad face'}$$

BOX 2

$$KG_{fr} = \sum_{PG \in fr} fP_{PG} \cdot fM_{PG} \cdot PKG_{PG}$$

PKG_{PG}	potential copper content. of product group *PG*
mPG	mass of copper in the product group *PG*
m_{fr}	mass of copper stock in functional range *fr*
fP_{PG}	execution frequency of product group *PG* (executed at all)
fM_{PG}	copper frequency of product group *PG* (executed in copper)

The intermediate PKG results are shown in Fig. 4.

Comparison of Cu stocks CH building vs. infrastructure

The copper stocks in the buildings and the infrastructure are about equal in size (~100±30 kg/capita). The amount and distribution pattern may differ in other regions (Fig. 6).

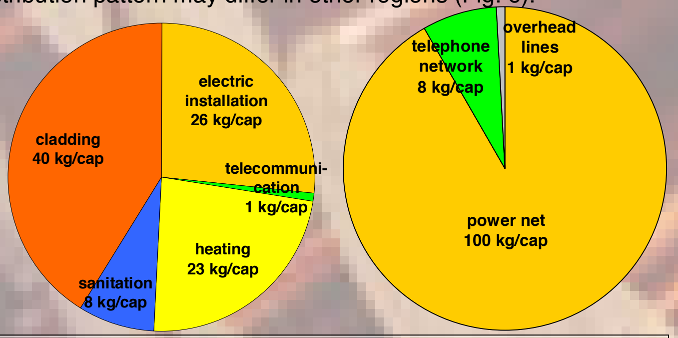

Fig. 5 Extrapolated copper stocks within the buildings of Switzerland for the 5 relevant functional ranges (left) compared with the infrastructure stocks (right). Both stocks given in [kg/capita].

Results

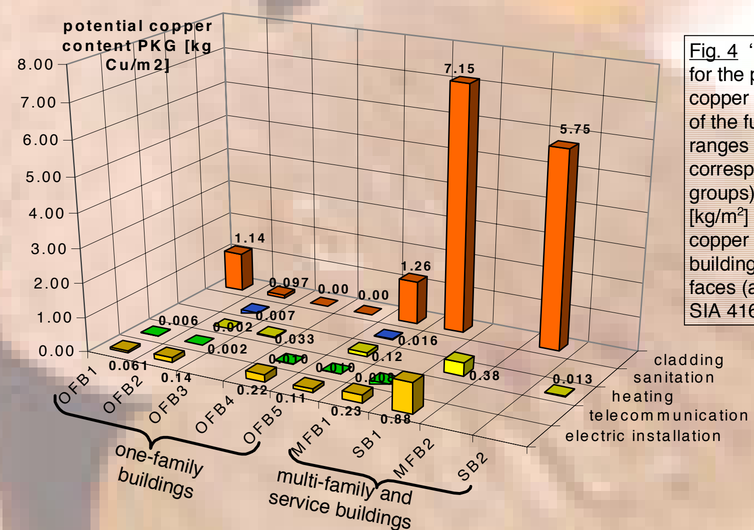

Fig. 4 'Measurements' for the potential copper contents (PKG) of the functional ranges (=sum of the corresponding product groups). The PKG [kg/m²] refers the copper mass to the building reference faces (according to SIA 416).

Outlook

Resource management requires further knowledge of the historic stock development and lifetimes to predict resource availability. Fig. 6 shows the example 'panel heatings' in Switzerland. Following, the stock development will be reconstructed for the period 1900-2000 by expertises and estimations about the KG parameters (cf. Box 2).

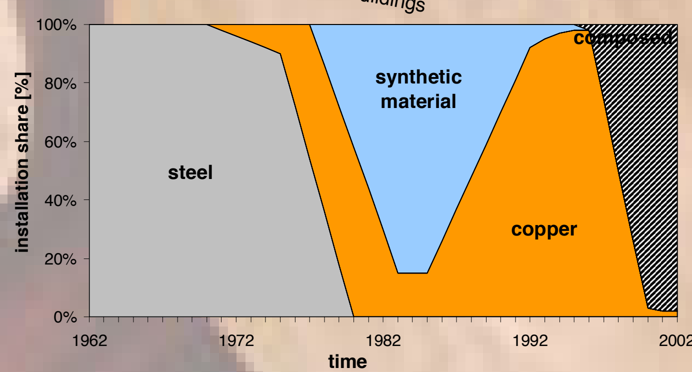

Fig. 6 Schematic developmental history of the installation distribution (market shares) for the different pipe materials in panel heatings since market launch.

References:
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