Available online at www.sciencedirect.com
SCIENCE DIRECT®
ELSEVIER
Environmental Impact Assessment Review 25 (2005) 540–566
Environmental Impact Assessment Review
www.elsevier.com/locate/eiar

The end of life treatment of second generation mobile phone networks: Strategies to reduce the environmental impact

Wolfram Scharnhorst[a,b,*], Hans-Jörg Althaus[a], Mischa Classen[a], Olivier Jolliet[b], Lorenz M. Hilty[a]

[a]*Technology and Society Lab, Empa, Swiss Federal Laboratories for Materials Testing and Research, CH-8600 Dübendorf, Switzerland*
[b]*Life Cycle Systems Group (ENAC-GECOS), Swiss Federal Institute of Technology, CH-1015 Lausanne, Switzerland*

Received 21 March 2005; received in revised form 21 April 2005; accepted 22 April 2005
Available online 2 June 2005

Abstract

A life cycle assessment was carried out based on a detailed life cycle inventory for a typical GSM 900 mobile phone network and related *E*nd *o*f *L*ife (EOL) treatment infrastructure. The environmental relevance of the three life cycle phases: production, use and EOL treatment was analysed using IMPACT2002+. The environmentally preferable EOL treatment alternative was identified on the basis of six previously developed EOL treatment scenarios.

The results indicate that the environmental impacts attributable to the use phase dominate the environmental impacts incurred over the entire life cycle of the network. The impacts of the production phase are primarily attributable to the energy intensive manufacturing of printed wiring boards (PWB). The EOL phase dominates the impacts on ecosystem quality. In particular the long-term emissions of heavy metals have critical effects. Detailed analysis of the EOL phase shows that recycling of network materials in general leads to a two fold reduction of environmental impacts: in the EOL phase itself as well as by means of the avoided primary production of materials recovered in

* Corresponding author. Technology and Society Lab, Empa, Swiss Federal Laboratories for Materials Testing and Research, CH-8600 Dübendorf, Switzerland. Tel.: +41 44 823 4830; fax: +41 44 823 4020.
E-mail addresses: wolfram.scharnhorst@empa.ch (W. Scharnhorst), hans-joerg.althaus@empa.ch (H.-J. Althaus), mischa.classen@empa.ch (M. Classen), olivier.jolliet@epfl.ch (O. Jolliet), lorenz.hilty@empa.ch (L.M. Hilly).

0195-9255/$ - see front matter
doi:10.1016/j.eiar.2005.04.005

the EOL phase. An increase in the material quality of the secondary precious and rare materials leads to a significant reduction in the impacts on human health.

Keywords: LCA; End of life scenarios; Waste management; Recycling benefit; Value correction factor; Mobile phone network

1. Introduction

Mobile telephony, today an indispensable service facilitating every-day life, has experienced a tremendous increase in penetration since the implementation of the innovative Global System for Mobile communication (GSM) standard in the early 1990's. Expressed in today's figures: more than 1.32 billion GSM subscribers (GSM world 2005) are connected to 626 GSM networks operated in presently 198 countries worldwide (GSMAssociation, 2004). Numerous further countries, in particular in the Latin-American and in the Asian-Pacific regions have just started the implementation of second generation (2G) mobile phone networks such as GSM networks (GSMAssociation, 2004). Forecasts on the evolution of the third generation (3G) *U*niversal *M*obile *T*elecommunication *S*ystems (UMTS) standard predict growth rates in networks and subscribers similar to those achieved with the GSM standard. If realistic, this progression would lead to about 500 million mobile phone users in 2010 in China alone (Friedl and Partners, 2001).

Closely associated with these trends is a fast-growing amount of mobile phone network infrastructure as well as subscriber equipment that need to be replaced. This is due to the fact that the different network components either no longer meet technical requirements or have reached their physical *E*nd *o*f *L*ife (EOL) due to damages or defects.

In recent years, national governmental authorities, manufacturers, operators and recyclers have discovered more and more adverse environmental implications caused by the processing of network components as well as by improper EOL treatment. Restrictive regulations seek to prevent the dumping of valuable electronic scrap and aim to increase the recycling rates of electronic devices (CEC, 2003a). Supporting regulations prohibit the usage of several materials thought to be environmentally toxic (CEC, 2003a,b). In order to meet the regulation requirements and to reduce the overall environmental impacts of mobile phone networks, manufacturers have endeavored to replace environmentally critical materials. Recyclers have updated their EOL treatment processes constantly to meet the latest environmental requirements. However, several major issues have not been addressed sufficiently yet:

a) The regulations on environmentally safe EOL treatment methods and emissions caused by processing the scrap are not consistent world wide.
b) The environmental impacts related to the EOL treatment of entire mobile phone networks have not yet been quantified from a life cycle perspective.
c) The implications of the increased amount of network scrap to be treated due to the change-over from 2G to 3G networks have not thus far been studied.