GSMA

Methodology

Estimating the number of dormant phones worldwide

June 2023

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Introduction

This document summarises the approaches, data sources, and assumptions used to develop the GSMA's preliminary estimate of the number of dormant mobile phones globally in 2023. Dormant mobile phones are defined as mobile phones that are kept by their most recent users in storage (e.g. in desk drawers, closets, cupboards, garages).

Several country-level estimates have been published in recent years[1], but there are no known published estimates at the global level. The most relevant data point comes from the UN Institute for Training and Research (UNITAR, 2022), which estimated that of the 16 billion mobile phones that exist, 5.3 billion will "drop out of use in 2022". However, this figure measures the flow of phones that could become inactive in 2022, rather than the total (cumulative) stock of dormant phones that are stored worldwide.

Given the lack of prior estimates and standardised methodologies, this analysis uses three different modelling approaches to estimate a plausible range of dormant phones worldwide. Based on the results of the three approaches outlined below, **the GSMA estimates that there are 5–10 billion dormant mobile phones in the world today.** The GSMA welcomes feedback on this analysis as well as additional data and analysis to help improve and refine these preliminary estimates.

1. Top-down estimate based on sales, stock, and connections data

Based on mobile phone sales and shipment data from Gartner, IDC, and other sources, an estimated 31 billion new mobile phones[2] have been sold worldwide between 2000 and 2022. These 31 billion phones can be grouped into four categories:

1. phones that have already been recycled, landfilled, and/or incinerated;
2. phones that are currently actively used and connected to networks;
3. phones that are currently sitting dormant in homes;
4. other phones, e.g. used phones that are in the process of being resold.

Based on the dataset for the Global E-Waste Monitor (Forti et al., 2020), UNITAR estimated that 16 billion mobile phones existed worldwide in 2022 (i.e. categories 2, 3, and 4) (UNITAR, 2022). This implies that 15 billion phones have already been recycled, landfilled, or incinerated (category 1).

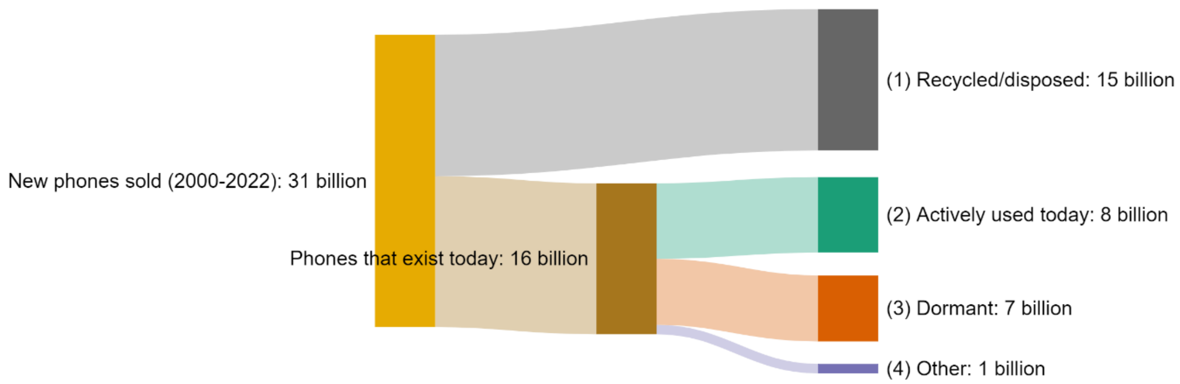
Data from GSMA Intelligence (GSMA, 2023; GSMA Intelligence, 2023) indicates that there are currently around eight billion phones that are actively connected to mobile networks (category 2). This implies that the remaining eight billion phones that exist today are either dormant (category 3) or otherwise not being actively used, e.g. in the process of being resold (category 4).

The vast majority of these eight billion phones are likely to be dormant (category 3), based on household surveys across diverse markets[3] which have found that typically 40–60% of

[1] For example, in Australia (Mobile Muster, 2022a, 2022b), France (Afnum et al., 2019), the United Kingdom (Deloitte, 2022; Virgin Media O2, 2022), and Europe, North America and New Zealand (rebuy, 2021).
[2] 16 billion smartphones and 15 billion feature phones.
[3] See Prabhu & Majhi (2023) for a comprehensive summary of key surveys. This analysis considered surveys conducted in Australia (Islam et al., 2020), Austria (Wieser & Tröger, 2018), Canada (CWTA, 2017, 2018), China (Bai et al., 2018; Cai et al.,

mobile phone users hold onto their old phones after they are replaced (Prabhu & Majhi, 2023). Conservatively assuming that no more than one billion phones are in category 4, **over seven billion dormant phones** are estimated to be stored in desk drawers, closets, and cupboards around the world (category 3). This top-down estimate is summarised in Figure 1.

Figure 1 – Summary of top-down estimate based on sales, stock, and connections data



Notes: "Other" includes used phones not included in the remaining three categories, e.g. used phones that are in the process of being resold on online marketplaces and second-hand shops.

Sources: New phones sold (GSMA analysis based on Gartner, IDC, and other sources); phones that exist today (UNITAR, 2022 based on Forti et al., 2020); phones actively used today (GSMA Intelligence, 2023); recycled/disposed (calculated based on the number of possessed phones estimated by UNITAR, 2022).

2. Global flow model

A second top-down estimate was derived using a global flow model that tracked how new mobile phones (by year of first sale) eventually reached the end of their active lifespans following a Weibull distribution[4].

The model assumed a hoard rate of 10% for phones sold in 2000, given the vast majority are likely to be landfilled or disposed already. It also assumed that half of all new phones sold in 2015 that had reached their active lifespans in or before 2023 were stored by the final user, in line with results from household surveys discussed above (Prabhu & Majhi, 2023). Weibull parameters were based on previous studies that modelled mobile phone lifespans (Golev et al., 2016; He et al., 2018; Polák & Drápalová, 2012). These assumptions are summarised in Table 1.

2020; Li, Li, Liu, et al., 2022; Li, Li, Lu, et al., 2022; Qu et al., 2019; Tan et al., 2017, 2018; Yin et al., 2014; Zhang et al., 2021), Europe (Directorate-General for Environment (European Commission) et al., 2022), Finland (Martela, 2019; Ylä-Mella et al., 2015), Hong Kong (Deng et al., 2017), India (Borthakur & Govind, 2019; Borthakur & Singh, 2021; Kwatra et al., 2014), Malaysia (Kamardzaman, 2019), the Netherlands (Inghels & Bahlmann, 2021; Uyttenbroek, 2017), Nigeria (Babayemi et al., 2017; Miner et al., 2020), Pakinstan (Shaikh, 2021), Portugal (Nowakowski, 2019), the United Arab Emirates (Attia et al., 2021), the United Kingdom (Martinho et al., 2017; Wilson et al., 2017), and the United States (Gozun, 2022).

[4] The Weibull distribution is a continuous probability distribution that can be used to model the failure times of equipment. It is used in this analysis to approximate the probability distribution of the mobile phones reaching the end of their active lifespan.

Table 1 – Assumed Weibull parameters, average active lifespan, and hoard rate

Year of first sale	2000	2010	2015
Weibull parameters			
α	3.5	2.5	2.8
β	6	2.5	3.3
Implied average active lifespan Total average active lifespan (including second and third use) based on Weibull parameters	5.9 years	2.7 years	3.4 years
Hoard rate Share of phones kept in storage by their final user after reaching end of active lifespan	10%	25%	50%

Sources: Weibull parameters based on GSMA analysis of Golev et al. (2016), He et al. (2018), and Polák & Drápalová (2012). Hoard rates are assumed for the purposes of this analysis based on household surveys reviewed by (Prabhu & Majhi, 2023).

Based on the assumed parameters, the model estimated that there are currently around **10 billion dormant mobile phones worldwide**. About half of this dormant stock are phones that have been manufactured since 2015, highlighting the significant share of dormant phones with potential to be refurbished and reused.

The results are moderately sensitive to the assumed Weibull parameters, implied average active lifespan, and hoard rates. For example, adjusting the Weibull parameters to reduce the assumed active lifespan to two years for all phones increases the volume of dormant devices to over 12 billion. Reducing the assumed hoard rates (e.g. 0% hoard rate for phones from 2000, 10% from 2010 and 30% from 2015) lowers the dormant stock to 6.7 billion. Additional data and model refinements, such as disaggregating feature phones and smartphones, could improve the robustness of this model and analysis.

3. Regionally-disaggregated bottom-up estimate using data from household surveys

To complement the top-down estimates, a regionally disaggregated bottom-up estimate was developed using data from published country-level household surveys (number of hoarded phones per capita) multiplied by population (World Bank, 2023). For regions where representative household surveys were not available (Sub-Saharan Africa and Latin America), assumptions for hoarded phones were based on available data from other countries or regions using other indicators as proxies, such as the number of cumulative number of phones sold in that region and GDP per capita. Given the inherent uncertainties with surveys and sampling differences between studies, this analysis uses lower and upper-bound assumptions to estimate a plausible range of hoarded phones.

The estimated number of hoarded phones per capita differ significantly between regions, reflecting differences in mobile phone sales, consumer behaviour, and the availability of take-back and e-waste management programmes. In North America, Europe, and other advanced economies, the cumulative number of new phones sold in these markets between 2000 and 2022 exceeds seven phones per capita. This analysis assumes that advanced economies have between 0.7 and 1.6 phones per capita (based on GSMA analysis of Afnum et al., 2019; Bitkom, 2018; CWTA, 2017, 2018; Golev et al., 2016; Gozun, 2022; Inghels & Bahlmann, 2021; Polák & Drápalová, 2012; rebuy, 2021; Speake & Yangke, 2015; Thiébaud, 2017; Uyttenbroek, 2017; Virgin Media O2, 2022).

China and South Asia (including India) have together accounted for about 40% of cumulative global phone sales since 2000. This analysis assumes that there are one to two hoarded phones per capita in China (based on GSMA analysis of Guo & Yan, 2017; He et al., 2021; and Li et al., 2022) and 0.7 to 1 phone per capita in South Asia (based on GSMA analysis of He et al., 2021 and Shaikh, 2021).

Developing economies are likely to have a lower number of hoarded devices, due in part to a lower available stock of phones in those markets (due to the later adoption of mobile phones) and a lower hoarding rate. Household surveys in these markets indicate that replaced phones are more likely to be given to family members, resold, or disposed, rather than hoarded. This analysis assumes there are 0.2 and 0.8 hoarded phones per capita in developing economies.

Based on these assumptions, the bottom-up model estimates that **5–8.5 billion dormant phones** are currently stored in homes worldwide. About one-third are located in China, one-quarter in South Asia, and one-quarter (combined) in North America, Europe, Japan, South Korea, Australia, and New Zealand.

Critical minerals

This analysis also estimates the volume of potentially recoverable critical minerals from used mobile phones based on a review of industry and academic sources (Apple, 2017; Bookhagen et al., 2020; Buchert et al., 2012; Geyer & Doctori Blass, 2010; Polák & Drápalová, 2012; Umicore, 2020; US EPA, 2015; Yu et al., 2010).

The assumptions for this analysis (Table 2) reflect a balanced mix of feature phones and smartphones in the overall stock of dormant devices. The total estimated mineral volumes are calculated on an assumed stock of five billion dormant phones that are responsibly recycled. Ideally, a significant share of the 5–10 billion dormant devices that are estimated to exist today would first be reused or refurbished to extend its useful lifespan, and only later be recycled.

Table 2 – Assumed volume of recoverable minerals from a used mobile phone

Mineral	g/phone
Copper	10
Silver	0.1
Gold	0.02
Palladium	0.003
Neodymium	0.2
Cobalt	10

Sources: GSMA analysis based on Apple, 2017; Bookhagen et al., 2020; Buchert et al., 2012; Geyer & Doctori Blass, 2010; Malmodin, 2023; Polák & Drápalová, 2012; Umicore, 2020; US EPA, 2015; Yu et al., 2010.

The total value of recovered critical minerals was estimated based on spot prices obtained from the London Metal Exchange (LME), Bloomberg, and Kitco on 19 June 2023 (Bloomberg, 2023; Kitco, 2023; London Metal Exchange, 2023a, 2023b).

The number of electric car batteries that could be supplied by the cobalt recovered from five billion mobile phones was estimated based on a 75 kWh electric car battery produced in

2024 based on the projected market shares of different cathode chemistries and their mineral intensities (Argonne National Laboratory, 2022; Greenwood et al., 2021; IEA, 2022, 2023a, 2023b).

To compare the amount of gold contained in a tonne of waste mobile phones compared with a tonne of gold ore, this analysis uses a global average ore grade of 1.42g/t in 2022 based on S&P Global Market Intelligence (Els, 2021).

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