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Global Circular Economy of Strategic Metals – the Best-of-Two-Worlds Approach (Bo2W)

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Work package 2.2:Status Analysis Egypt

Work package 2.4:Generation of WEEE and ELV

Work package 3.2: Status Analysis Egypt regarding collection, sortig and pre-treatment

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Ghana

<u>Disclaimer:</u>

This report reflects the situation as of Summer / Autumn 2013. New data and developments since then are not considered. More information regarding more recent developments, for instance regarding new initiatives of the Ministry of Environment or the National Solid Waste Management Programs or Refuse Derived Fuel (RDF) for cement kilns might be considered in a subsequent report accordingly.

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g	grams
CAGR	Compound annual growth rate
ELV	End-of-life vehicles
EoL	End of life
GDP	Gross domestic product
GNI	Gross national income
hh	Households
ICT	Information and Communication Technology
km	Kilometre
km^2	Square kilometre
LE	EGP (E£)
NB	Nota bene – note well
PC	Personal Computer
WEEE	Waste electrical and electronic equipment
%	percent

1. Country overview Egypt

The North African country of Egypt is sharing borders with Libya, Sudan, Israel, and the Gaza Strip. Egypt has a coastline of 2,450 km (Mediterranean Sea and Red Sea) and covers an area of 1,001,450 km^2 including the Asian Sinai Peninsula (CIA 2013). The map of Egypt with the governorates is shown in Figure 2.

Egypt has a population of 81.4 million[1] with an annual growth rate of 1.9 % (CAPMAS, statistical yearbook 2012, population). 43.4 % of the population lives in cities. Cairo, the country's capital is the largest town with 8.762 million inhabitants followed by Alexandria with 4.5 million. (CAPMAS 2013, statistical yearbook 2012, Population)

Table 1 below shows selected figures and indicators for Egypt.

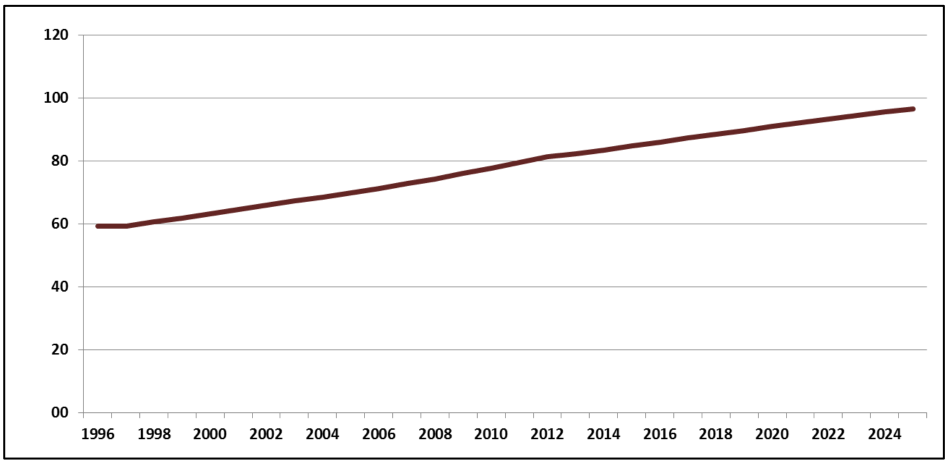
Table 1 Selected figures and indicators for Egypt

Indicator	
Area	1,001,450 km^2
Population	81.4 million
Population growth rate	+ 1.9 % per year
Urban population	43.4 % of total population
Capital & biggest city	Cairo (8.762 million inhabitants in 2012)
GDP per capita	US$ 6,600
GDP-growth	+ 2 % (2012)
GDP – composition by sector	agriculture: 14.7 %; industry: 37.4 %; services: 47.9 %

Source: CIA 2013, CAPMAS 2013 statistical yearbook 2013 population

1 Different population data is available. According to CIA 2013, the population is 85.3 million. It is assumed that the CIA data include also the Egyptians not living in Egypt. CIA 2013 also provides slightly higher population figures for the cities: Cairo 10.902 million in 2009 and Alexandria 4.387 million

Figure 1 Population projection for Egypt in total [in millions]



Source: based on Statistical Yearbook 2012, CAPMAS; Variante "Medium" in Egypt

Egypt has experienced dramatic changes since the revolution in 2011 when President Hosni Mubarak was overthrown.

The economy of Egypt is still suffering a severe downturn. The government faces large challenges e.g. how to restore growth, market and investor confidence. The economic growth is still negatively affected by political and institutional uncertainty and perception of rising insecurity.

“Real GDP growth slowed to just 2.2 percent year on year in October-December 2012/13 and investments declined to 13 percent of GDP in July-December 2012. The economic slowdown contributed to a rise in unemployment, which stood at 13 percent at end-December 2012, with 3.5 million people out of work. Foreign exchange reserves have continued to decline and are now less than 3 months of imports.” (World Bank 2013 EG)

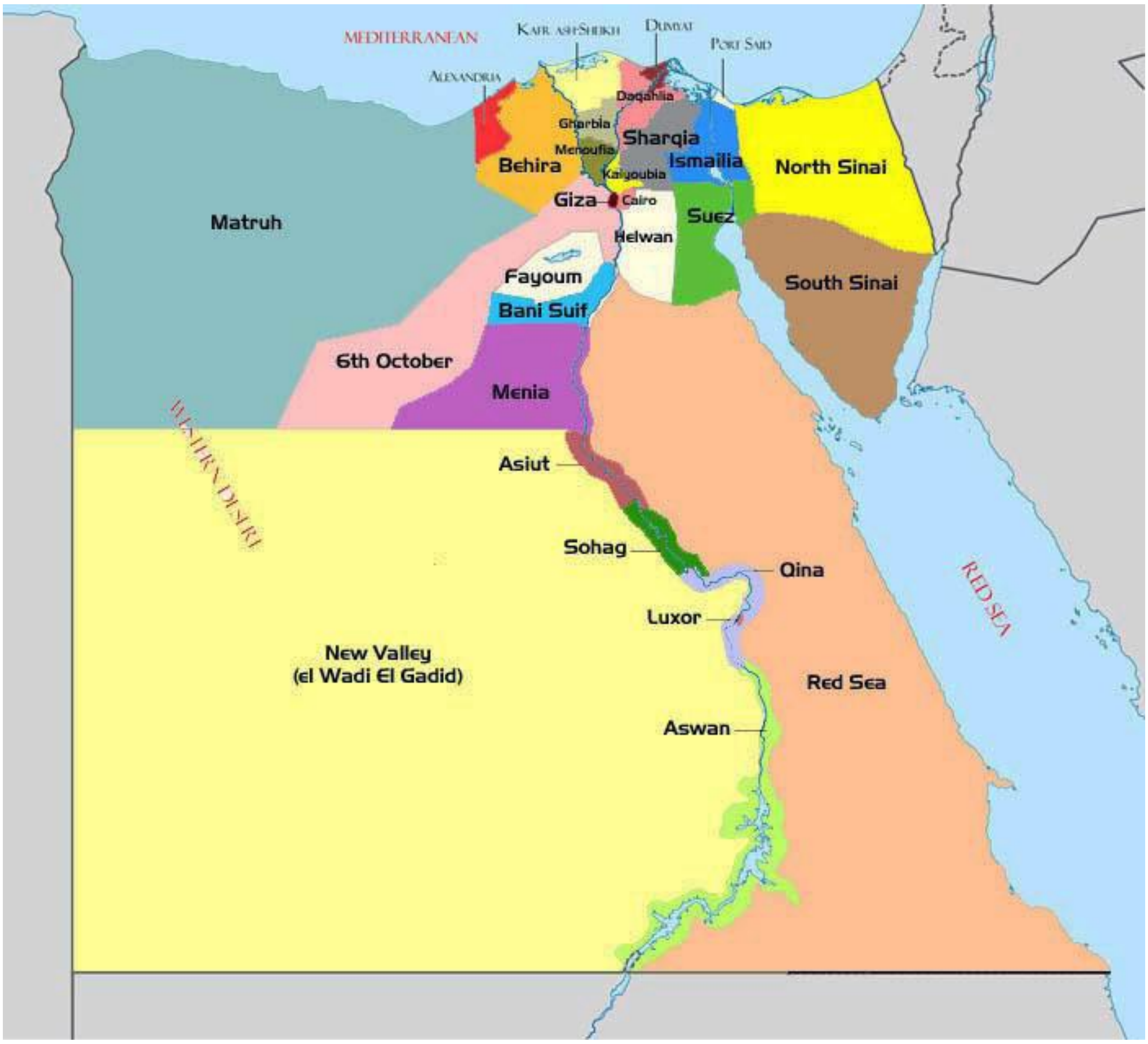
Around 25 % of the population is living belowthe national poverty line (Poverty headcount ratio at national poverty line, World Bank 2013).

More than the half of the labour force is employed in the tertiary sector (services), followed by 32 % in agriculture and 17 % in industry business (CIA 2013).

Due to the geographical location among three continents as well as the location of the Suez Canal which is considered one of the most important water passages in the world, the transport infrastructure plays an important part. The roads´ length is in total 120 722 km (14 322 km unpaved roads, 106 400 km paved roads) increased with the strongly growing number of licensed vehicles in the last years (2011: 6 322 433 licensed vehicles). (CAPMAS, Egypt statistical yearbook, 2012)

The railway length has remained unchanged in the last years at around 5 000 – 5 500 km. Increasing revenues are generated with the Suez Canal. In 2011, around 5 000 million dollars were raised through fees charged to the 18 000 ships and vessels which passed through the Suez Canal in that year. Ports play also an important transport medium in Egypt to move goods, passengers as well as vessels. Further information on tonnes and number of passengers for 2009 and 2010 are available in CAPMAS statistical yearbook 2012, Transport and Communication.

Figure 2 Map of Egypt



Source: FAO 2014

2. Evaluation of resource potential from waste products (Work Packages 2.2, 2.4, 3.2)

2.1. Overview of the waste management sector in Egypt (Work Package 2.2)

2.1.1. Development, infrastructure and ICT-penetration

The development indicators in the following Table 2 and Table 3 provide an interesting background to the evaluation of the e-waste and car-waste situation.

Table 2 Selected development indicators for Egypt

Indicator	Unit	Year of data	Egypt	Source
Human Development Index	Rank	2012	112	UNDP 2013
Human Development Index	Value	2012	0.662	UNDP 2013
Population below national poverty line	% of the population living below the national poverty line	2011	25.2 %	World Bank 2013
Urban Population	% of total population	2011	44 %	World Bank 2013
Adult literacy rate	% of people aged 15 and above	2010	72 %	World Bank 2013
Youth literacy rate	% of people aged 15-24	2010	88 %	World Bank 2013
GNI	PPP $ billions	2011	504.8	World Bank 2013
GDP growth	%	2011	1.8 %	World Bank 2013
Population without electricity	%	2009	0.4 %	World Bank 2013

Source: UNDP 2013, World Bank 2013
Data for Ghana and other countries see Report Chapter Ghana

Table 3 Selected ICT and transport indicators for Egypt

Indicator	Unit	Year of data	Egypt	Source
Mobile-cellular telephone subscriptions	per 100 inhabitants	2012	116.94	MCIT ICT Indicators 2013
Population covered by mobile phone network	%	2008	95 %	EconStats 2013
Internet users	%	2011	38.7	World Bank 2013
Fixed (wired) broadband subscriptions	per 100 people	2011	2.21	World Bank 2013
Households with a computer	%	2010	34.00	ITU 2012
Motor vehicles	per 1000 people	2011	79	Calculation based on CAPMAS statistical yearbook 2012
Passenger cars	Per 1000 people	2011	43	

Source: ITU 2012, MCIT ICT Indicators 2013, World Bank 2013, EconStats 2013
Data for Ghana and other countries see Report Chapter Ghana

Based on the information displayed in Table 2 and Table 3, some first assumptions can be made regarding the use of electrical and electronic products within the country.:

- 22 % of the country's population live on less than US$ 1.25 per day (World Bank 2013). These people are not economically capable to purchase any type of expensive product such as electrical and electronic equipment, motorcycles or cars.
- 28 % of the adult population are illiterate; this means that one fourth of the adult population are excluded from using information and communication technologies such as computers. As youth literacy rate is 88%, the share of the adult population considered illiterate will gradually decline in the future (World Bank 2013).[2]
- In 2008, almost the entire Egyptian population (99.6 %) was connected to an electricity supply (World Bank 2013).
- In 2011, mobile phone subscriptions exceeded the country`s population number[3] (MCIT ICT Indicators 2013).
- In 2010, 34.0 % of the Egyptian households owned a computer (ITU 2012).
- In 2010, 94.1 % of the Egyptian households owned a TV (ITU 2012).
- The number of licensed vehicles increased significantly from 2005 (3.7 Mio. licensed vehicles) to 2011 (6.3 Mio. licensed vehicles). The main agglomeration area of licensed vehicles is the Governorate Cairo (including Helwan) with 2 Mio. vehicles in 2011.

[2] Regardless of the high illiteracy rate, a high rate of market saturation is assumed for mobile phones

[3] For more details, please refer to Annex, Assumptions for mobile phones in Egypt

Especially in Cairo, road traffic increased significantly over the last years. (CAPMAS, statistical yearbook 2012; Transport 2013)

2.1.2. Status analysis of the waste management and recycling structure

The following Chapter, if not stated otherwise, is based on insights provided by Mounir Bushra/CEDARE (2013). It focuses on the collection infrastructure as well as first sorting steps of municipal solid waste (MSW) including the description of relevant actors. With respect to the present situation of waste electric and electronic equipment (WEEE) and end-of-life vehicles (ELV) it gives an impression of the current collection and trade pathways. The description of the subsequent processing steps for WEEE and ELV (pre-treatment and recycling) is the subject of a later report.

2.1.3. Municipal solid waste management

Approx. 21 million tonnes of municipal solid waste are generated in Egypt per year (Sweep-Net 2012). However, waste collection systems have not been implemented nationwide. According to Sweep-Net (2012) coverage ranges between 40 % and 85 % in urban and 0 % and 35 % in rural areas. In general, waste collection rates are higher in higher income residential areas than in lower income areas.

The main actors in the Egyptian market of solid waste collection are described in the following:

The municipality – by law – is responsible for waste collection and disposal in all urban areas – and theoretically the rural areas as well. However, the public service in rural areas is often not working. In Cairo and Giza there are independent institutions (Cairo Cleansing and Beautification Authority (CCBA) and Giza Cleansing and Beautification Authority (GCBA)) which are responsible for waste collection and disposal separately from the district management. They have parallel offices and closely coordinate with the district management. The other governorates take care of waste collection and disposal through their city districts. It is worth mentioning here that Minya Governorate is the only rural governorate which has an independent organizational structure for waste management that coordinates the district management in this regard, as waste collection and disposal duties are still the responsibility of the citydistricts.

The public authorities either carry out the services themselves or contract private operators (e.g. national or international waste companies).

These formal private sector companies generate their income solely from the collection service fees as they dump the waste directly in the public final disposal facilities. However, some companies run composting facilities which sort out some of the recyclables and produce marketable compost of varying quality, thus generating additional income.

Another important private actor are the traditional - and sometimes informal - garbage collectors and processors (the Zabbaleen – plural, as it singular is Zabbal which means by the garbage collector – constitute another important group in the Egyptian waste management sector). They are either directly licensed by the authorities or are subcontracted by formal private companies. They collect waste directly at front doors from their clients who are residing mainly in the high and middle income districts. The collected waste is then transferred to their homes, where it is sorted into its main components. The recyclable materials (e.g. plastics, paper, metal and glass) are sold to waste dealers, and the organic fraction was – until recently - used to feed their pigs. However, after banning this business for its swine flu potential, organic waste is now rejected to be finally disposed in the public dumps and landfills. The Zabaleen generate their income from service fees and waste recovery.

Additionally, as collection coverage is often inadequate, Non-Governmental Organizations (NGOs), and Community Development Associations (CDAs) or Community Based Organizations (CBOs), are providing waste collection services in very few urban areas and in many villages. The urban NGOs are working – most of the time – as sub-contractors for private companies.

Self-Collection is a service provided by the service recipient at the same time. Army for example do not allow private contractors to collect its waste for security reasons. Therefore, the army staff may do that for their units.

Waste which is not collected is mainly dumped on open (dry) or in/along waterways (river banks, drainage canals).

2.1.4. Structure and relevance of the mainly informal traditional collectors (Zabbaleen)

As the traditional and informal garbage collectors play an important role in Egyptian waste management, their structure is described in more detail in the following. Their activity is concentrated in the Greater Cairo Urban Region (Cairo City – 4 settlements, Giza City - two settlements and Shoubra El Khema City – 1 settlement). There used to be 7 settlements in this area, five of which are existing until today:

<u>Ezbet El Nakhl Settlement</u> - still existing - It is close to Shoubra El Khema city and collects waste from this area to the Eastern part of Cairo such as Mataria, Heliopolis and Shoubra. Its population now is about 60,000 inhabitants (estimated). Beside waste collectors there are also many recoverers, processors, recyclers and dealers located there, in addition to the other supporting businesses such as maintenance workshops and other commercial establishments. It receives about 2,000 tons of waste per day.

<u>Moquattam (or Manshiet Nasser) Settlement</u> - still existing - It is located in Cairo close to Moquattam districts. It covers the areas of downtown Cairo, part of Nasr City and Heliopolis, and other areas close to it. The first waste recycling programs (Oxfam 1983 to 1992) and other pilot projects had started there through direct funds from Ford Foundation Catholic Relief Services and the Coptic Church from 1980 to present. The population is about 80,000 inhabitants (estimated). They recycle a good part of the waste generated in Cairo and the majority of waste recycling workshops and equipment are located there. As big waste dealers are living there as well, this area is receiving both raw waste to be recovered and recycled as well as sorted waste materials to be reprocessed and recycled or sold to big waste recycling plants in Cairo. It receives about 3,000 tons of raw waste and already sorted waste material per day.

Tora Settlement - moved to Kattamia area - the inhabitants of the Tora settlement used to live on military land and were moved to Kattamia area as part of a bigger program to resettle the whole Zabbaleen settlements outside the city skirts. The developmental projects there are managed by an NGO (The Association for Protection of the Environment – APE). The population is about 5,000 as this settlement in particular was one of the smallest four settlements in the Greater Cairo Urban Region. They have almost the same services and activities as the other similar settlements, but on a smaller scale. However, it is worth mentioning here that APE has established a plant to manufacture waste recycling equipment (e.g. plastic granulators, extruders, waste paper and iron presses, and other relevant equipment). The same NGO has a branch in Moquattam Settlement (the original one), where there is a pilot and ideal waste paper and rags recycling school and workshop for handicrafts made of these waste materials, in addition to other cultural and educational services.

Al Moatamadia Settlement - still existing - It is located behind Ard El Lewa, Giza. Its population is estimated to be about 30,000 inhabitants and possibly more. The original area was diminished due to the public works made for establishing the Axis Road (El Mehwar). It is the third settlement in population, workforce and amount of waste to be handled after Moquattam and Ezbet El Nakhl. It is estimated that up to 500 tons of waste are received by this area. As they live in a private agricultural area, they are not entitled to have 3-phase electric cables wich has implications for the waste recycling activities.

Al Baragil Settlement - still existing – This is a very small Zabbaleen community with similar living conditions as Al Moatamadia. The community receives up to 30 tons of waste per day and are connected to Al Moatamadia Settlement by a road located between the two settlements, business and other relations. Its population does not exceed 500.

Batn El Bakara – removed from its place - Its people have moved to other settlements or quit working in the waste management sector. It was located in the area west to Tora Settlement, in a densely populated and low income residential area.

Helwan Settlement - removed from its place - Its people have moved to other settlements (reportedly to 15th of May City) or quit working in this field. It was located at the end of Helwan district close to the desert.

The importance of the informal sector can be attributed largely to the following factors:

- It is an employment generating business, as it was estimated before that one ton of waste can employ about seven workers – based on assumptions made for door-to-door waste collections: three workers can collect one ton, which is transported by one worker, primarily sorted into its main components by one more worker and anther two workers are required for working in secondary sorting, processing, recycling and trading.
- It is a waste minimization and valorisation business: on average, 10% of the mixed waste from households and mixed waste similar to household waste collected by the informal sector is recovered. At the time when they were raising pigs, at least 50% of the organic fraction was used as feed. This is beneficial for two reasons. On the one hand, this reduces the amount of waste which has to be finally disposed of and so

extends the life time of the public dumps or landfills. On the other hand, material is recovered with positive effect (to some extend) on the import export balance.

- The income generated from waste recovery and recycling has a positive effect on the cost of the waste collection service provision.

NB: However, this work is not accepted by most ordinary people, which means that it is hard to replicate it everywhere.

2.1.5. Links between informal and formal collection and waste management systems

There are severall links between the formal and informal collection and waste management systems. Firstly, the traditional waste collectors (Zabbaleen) were acting as sub-contractors in at least two zones in Cairo (which each zone made of 7-8 districts), especially in the areas where waste is collected via door-to-door collection systems. The benefits of this practice are based on the vocational skills of the Zabbaleen (long-standing experience with collecting waste from high buildings), their trustfulness to residents as well as their knowledge of addresses, and the fact that they take the collected waste to their settlements which means that the main contractors save waste collection trucks, workers and loads. As a matter of fact, many formal companies in waste collection – especially the small ones – just hold the collection license from the municipality and sell the routes later to the informal bodies.

The second link happens when - through a network of waste dealers - the materials sorted and marketed by the informal collectors are delivered to (formal) waste recycling factories and companies.

Moreover, most of the time, there is an agreement between the municipality and the informal bodies who live in specific settlements to facilitate dumping their rejects in the nearest dumps based on payments to the formal body. The Zabbaleen may have annual contracts, which comes much cheaper than paying per single load or for permits valid for shorter periods. In some cases some individuals, especially those who collect small amounts of waste and consequently generate very small amounts of rejects, dump their rejects in the nearest vacant lots or open areas, and sometimes around their settlements.

2.1.6. Creation of added value from waste

There are many channels through which value is added to the waste stream, mainly by the informal sector:

As for the waste collected by the Zabbaleen, it is sorted into marketable waste material (recyclables), animal fodder and reject. Recyclables are sold to a series of waste dealers who process waste (e.g. baling, washing, crushing) and sell it on to waste recyclers. The organic fraction is fed to animals and therby converted into meat.

A second informal way of adding value to waste is scavenging. Scavenging, the selective picking of recyclables from mixed solid waste, either happens from dumpsters in the streets which are used by municipalities and formal collection companies to store waste before it is collected. Moreover, recyclables are scavenged from open dumps. The recovered material then passes through the same channels from waste dealers to waste recyclers after some processing.

On the formal side, some of the waste is sent to composting plants, where it is sorted for recyclables through hand-picking belts, and recovered materials (e.g. plastics, paper, textiles, iron) are baled in fractions and sold to waste dealers through open bidding. The fractions are either processed further or sold to waste recyclers.

Finally, recovery of source-segregated waste happens at specific commercial places like press houses (for waste paper), slaughter houses (for bones), restaurants (for pure organic waste).

The descending pyramid of waste material according to market value is as follows:

- Non-ferrous metals such as copper, brass, aluminium, zinc, and lead
- Baled tin cans
- Waste plastics, mainly PET and PE
- Paper in general, especially white cuts and cardboard
- Animal bones
- Textile (white new cotton) followed by new coloured, to synthetic to post consumer textile
- Glass waste starting with complete bottles, white transparent cullet and then coloured

2.1.7. Final waste disposal

The main final disposal option in Egypt is open-dumping (unmanaged landfills). According to Sweep-Net (2012) 85 % of the collected MSW are managed by this practice. Few managed/sanitary landfills exist, accepting approx. 5 % of the collected MSW, according to the same source. Also, the uncollected fraction is generally dumped on open (dry) or in/along waterways (river banks, drainage canals).

Waste is not burnt openly in large quantities. However, it can happen naturally (self ignition) and in some cases it is used to clear the area of an open dump. Technical incinerators exist in Egypt, but are not working for various technical and economic reasons. However, some hospitals still operate incinerators to get rid of their medical waste, and in some places there are incinerators to serve a group of hospitals and medical institutions (e.g. Cairo University Hospitals). Incinerators are either imported and expensive, or locally made in the Military Factories and cheaper.

2.1.8. Situation of current WEEE management in Egypt (Work Package 3.2)

2.1.8.1. Informal repair, reuse and recycling systems for WEEE

Informal structures dominate the waste sector, especially in the WEEE sector. For the informal sector, there are four main public markets in the Greater Cairo Area in which small trade men can sell their harvest of used EEE and WEEE and their spare parts:

- Shoubra El Khema Public Market (in Manshiet Abdel, on a weekly basis in Monem Riad)
- Imbaba / El Warrak Public Market, on a weekly basis (in El Basrawy Street).
- El Kollaly Public Market, open all days (starting from El Sabtia and El Torgoman Bus Station)
- El Imam El Shafiies Public Market, on a weekly basis (down El Tounsy Bridge).

2.1.8.2. Major e-waste dealers

For example, there are three e-waste dealers in the Zabbaleen community of Manshiet Nasser (or Moquattam):

- Taqawy Kirolos is an e-waste dealer who buys computer boards, computer cases, and hard disks. He buys 100 kg/week from all the Zabbaleen communities in Manshiet Nasser, Ezbet El Nakhl, and Tora. He also used to buy 200 kg/week of the aluminium-backed hard disks and chaises with hard disks from the Zabbaleen communities and sell them to bigger dealers. Taqawy did not want to communicate the material prices.
- Adel Aziz buys only steel casings or any other steel metal which can be extracted from computer scrap. He buys about 400 kg/week from the Zabbaleen communities at 0.85 LE/kg and sells it – after separation into stainless steel, galvanized steel, etc. – at about 2 LE/kg and at 1.25 LE/kg for ordinary iron.
- Helal Mahrous, who is a dealer of San'a (mixture of materials including e-waste), is specialized in key boards, screens, and other small equipment, as well as big equipment such as copy machines, scanners, printer, etc.. He buys these elements by weight or by piece. He informed us that he buys around 500kg of e-waste per week, but did not communicate prices with a few exceptions, such as the price for damaged items sold as waste plastic at 0.75 LE/kg. Scanners and printers for example are sold to him by piece at around 20 - 50 LE each, depending on their condition and market demand. The damaged equipment is crushed together with the scrap material (e.g. plastic and metals) and are sold to waste dealers, while the reusable items are sold to specific trade men who offer these items in El Imam El Shafiie (Souk El Tounsy or Souk El Goma'a) or in repair workshops, where a scanner in a good condition may be worth 75 to 150 LE/piece.

In Shoubra El Khema there are two major e-waste dealers:

- Ayman Brakat who has been working in this trade for five years handles the metal cases of old fridges and washing machines and sells them to a steel mill in Al Ain Al Sokhna. He buys scrap metal at 1,000 LE/ton and sells it at 1,100 LE/ton. He also buys this equipment if it is in fairly good condition at 75 LE for a washing machine and 150 LE for a fridge.
- Magdy Makram has been working as an e-waste dealer for 10 years. He buys used equipment (especially TVs, fans, and cassette recorders) and sells them to 2-3 small workshops which either repair and sell them to less well-off people or dismantle them and sell them as spare parts. Magdy reported that some people are looking for the mercury contained in old Phillips TVs. He mentioned that there are almost 50 technicians who can recover precious metals from computer boards and that the biggest dealer in this trade called Hamada is buying used equipment in bulk from the factories of 10th of Ramadan City and exports some of these abroad.
- Reportedly, there is a separate local network between those who recycle precious metals (especially gold and silver) and those who use these metals in decorating and painting household ware (dishes, plates, cups, spoons, etc.).

2.1.8.3. Dominant clusters for WEEE repair, reuse and recycling

The dominant clusters where WEEE repair is typically carried out are mostly concentrated in the big cities such as the Greater Cairo Urban Region, Alexandria, Tanta, Mehalla and Mansoura in the Delta in addition to Assiut in Upper Egypt. More specifically, the workshops are located in the densely populated and largely middle and low income areas, where residents sell their WEEE and there is a market for repaired EEE. For example, such workshops in Cairo are located in areas such as Mataria, Manshiet Nasser, and Shoubra El Khema. WEEE recyclers normally work in clusters (e.g. blocks or streets) and mostly work on one or more of the various WEEE recycling activities. For trade, there are some places where WEEE is sold to public openly in famous markets such as the Friday market in old Cairo (Salah Salem down to Moquattam, under the bridge). In such markets, hundreds of merchands who specialize in selling some specific WEEE (e.g. some sell ACs, PCs, fridges, mobile phones, parts of all, cables of all kinds, etc.). Each merchand may have just an open area on the street directly, a kiosk, or a stationary shop to work alone or with the assistance of other workers.

WEEE recycling workshops/activities are divided into the following categories:

- E-waste dealers who buy and sell WEEE as it is.
- Dismantlers of WEEE who sell reusable parts to maintenance and repair workshops and the other recyclable parts to waste dealers and recyclers.
- Repairers of used EEE using old spare parts from WEEE.

- Workers dealing with the extraction and metal recovery from specific WEEE parts, especially processors and printed wiring boards which are used in TV sets, computers, and alike. They sell the recovered material to other dealers who may use it or export it to China for example.
- Workers who collect and classify the processors and printed wiring boards and also export them to China.
- Recyclers of non-complex WEEE fractions such as plastics and metals.

Typically not-utilised fractions

The following fractions are typically not utilised or sold:

- Leftovers from processors and printed wiring boards after all precious metals have been extracted
- Styrofoam from fridge insulation
- Mixed hard fibre boards with plastics or metals
- Rusted small iron parts

These fractions are considered rejects and are typically dumped in the nearest open dumps.

2.1.8.4. Formal activities in the WEEE sector in Egypt

Currently, there are first signs (first companies are recently established like EERC and Recyclobekia) for formal WEEE collection and recycling established in Egypt. It should be mentioned that the Ministry of ICT hosted the Green ICT Group for several years which consists of OEMs (mobile phone companies etc.), recycling companies, NGOs, and representatives of administration. One of the topics the Green ICT Group focusus on is to address the rising e-waste problem in Egypt. However, there are some collection activities by NGOs (e.g. Resala) which collect WEEE and used EEE alongside with other waste material such as paper and clothes and sell them to sponsor their charity activities. Their collection strategy focusses on collecting donations from individuals. It is limited to Greater Cairo, Alexandria and some big cities in delta and upper Egypt, where most of the consumers and users are residing. They have no equipment, but WEEE or used EEE are collected as they are to be sold again to waste dealers and repairers. To given an example, the table below shows the number and types of used and waste EEE which were collected by Resala NGO for 2010.

Table 4 **Quantities and selling prices of WEEE/used EEE collected by NGO Resala in 2010**

N°	Item	N° of items collected by Resala in 2010	Total Price in LE	Average Price in LE/unit
		Units/year	EGP (E£)	EGP (E£)
1	Clock	11,219	125,553	11.2
2	Full Automatic Washing Machine	5,238	614,120	117.25
3	Dish Washing Machine	817	44,250	54.2
4	Water Heater	4,055	178,615	44
5	Fridge	7,962	1,078,604	135.5
6	Deep Freezer	1,567	201,753	128.75
7	TV	13,602	913,991	67.2
8	Video Player	3,053	140,290	46
9	Receiver	2,342	80,735	34.5
10	Cassette Recoder	12,893	308,013	24
11	Iron	5,518	90,957	16.5
12	Fan	11,653	413,832	35.5
13	Air Conditioner	698	102,240	146.5
14	Telephone	11,261	134,833	12
15	Vacuum Cleaner	5,659	270,162	47.75
16	Mixer	2,683	53,370	20
17	Microwave Oven	816	26,585	32.6
18	Air Blower	1,610	29,231	18.2
19	Air Heater	2,088	44,535	21.3
20	Lap Top	358	34,325	96
21	Computer Monitor	7,273	233,676	32.2
22	Computer Casing	5,707	211,605	37
23	Printer	3,347	93,833	28
24	Scanner	619	18,050	29.2
25	Key Board & Mouse	11,712	74,421	6.35
26	Sewing Machine	2,250	103,236	46
27	Tricot and Over	427	19,013	44.5
28	Copier	291	29,905	103
29	Video Camera	100	7,620	76.2
30	Camera	814	12,010	14.75
31	Hair Styling Machine	1,521	22,058	14.5
	Total	**139,153**	**5,711,421**	**41**

Resala NGO here is acting like the traditional waste street peddlers, which buy scrap and used equipment directly at front doors. However, the NGO receives the items as donations instead of paying for them (or for any other waste donations they receive). As another example, the NGO Spirit of Youth in Manshiet Nasser collects mainly old/used computers also on a donation basis to refurbish and resell them at low prices.

Additionally, there are some commercial private start-ups in the e-waste sector. As an example, the company Recyclobekia tries to motivate big private companies worried about greenness of the end-of-life treatment of their WEEE or environmentally conscious individuals (e.g. students) via their website and social media to give them their WEEE. The donors in turn receive green certificates and, for companies, publicity for their environmentally sound treatment. The collected WEEE are partially dismantled and sold for further processing and recycling, mainly abroad. Another example is the International Technology Group (ITG). It is one of the first factories not only in Egypt but also in the Middle East in the field of e-waste recycling & refurbishing IT equipment. It was established in 2011 according to Egyptian investment law 9 with a capital of 100 million Egyptian Pounds. The company itself claims that their mission is sharing in Green & Clean environment in Egypt and to increase recycling rates in a safe, secure and clean way. Their capacity for e-waste recycling is 700-800 tonnes per month (ITG 2014).

Source-segregated WEEE from public authorities are offered to the market via auctions where the highest bidder gets the lot. Furthermore, other items, e.g. furniture are offered together with the WEEE which makes this source less attractive for companies specialised in e-waste recycling. As a consequence, the bids are generally obtained by the informal sector which can offer higher prices, since they can resell or dump the furniture too.

Concerning the reuse of WEEE components, there are a few hundreds of small and micro workshops which maintain and repair used EEE and therefore use WEEE as a source of spare parts. In general, the technical status of an item determines whether it is considered used EEE or WEEE: units which can be refurbished will be repaired and sold to the less well-off, while units which cannot easily be repaired or for which repairing would not be cost-effective will be dismantled and used for spare parts. Unusable parts will be sold to waste dealers for recycling purposes or exported to other countries.

In general, it can be stated that the informal sector plays a significant role in the e-waste management in Egypt.

2.1.8.5. Characteristic challenges for the formal WEEE recycling systems

The establishment of formal and efficient WEEE recycling systems faces two main challenges:

The first is the legal constraint, as currently no laws addressing waste management for WEEE exist or are being developed in Egypt. In other words, there is currently no way to legally specify the collection of WEEE as an input to a formal business or industry. As it is complicated to define WEEE as a fraction by rigid law (more complex than in the case of plastics, glass or metals) the uncertainties of defining inputs will open doors for cheating and corruption.

The second constraint is the organizational one. WEEE recycling requires a great deal of elasticity and flexibility for handling a complex WEEE material input. Furthermore a sound knowledge base is necessary to select the most appropriate processing techniques and operational approaches. EEE technology is growing very fast and components and materials are changing rapidly at short intervals. Thus the handling of WEEE is more easily handled via private small entrepreneurship than via rigid of public systems.

2.1.8.6. Situation of current ELV management

Concerning ELV there is no formal collection in Egypt. However, formal recycling is established, especially in the lead industry. The recycling facilities are described in a subsequent report.

One specific pilot project in the Greater Cairo Area targeted the exchange of very old taxis. As a result, 41,000 taxis out of 43,000 eligible for the programs were taken back and formally scrapped. There is a plan to extend the scheme to micro-busses, however, due to the current political situation, the schedule is not clear.

Concerning the collection of lead-acid batteries, most, if not all, auto repair workshops with emphasis on and more specific to those which repair lead-acid batteries accept old and post-consumer car batteries. They pay approx. 10 LE per piece for small batteries and more for bigger ones.

As described for WEEE in the previous section, there are also many establishments in Egypt which focus on the reuse and repair of ELV. The establishments are mainly concentrated in the Greater Cairo Urban Region (Cairo, Giza and Shoubra El Khema cities), Mansoura, Tanta, and Mehalla Kobra cities in the Delta and Alexandria city/governorate. They carry out different forms of maintenance and repair, and buy and sell used equipment - of the above mentioned categories - and their spare parts. In Cairo for example, the trading business is concentrating in Wekalet El Balah, Boulak, and El Sabtaia.

The used and post-consumer equipment which can technically be repaired is refurbished and sold at much lower prices to other users and contractors, while the very damaged equipment is dismantled and sold as spare parts, especially expensive or out-dated equipment. There are very many skilled workers who make a good living from this trade, often by reassembling new equipment from old spare parts.

The pathways for final treatment of ELV (except for the lead acid batteries) as well as the potential role of the informal sector in this field remain to be investigated.

2.2. Potential scenarios for Egypt (AP 2.4)

A starting point for the calculation and prediction of the volumes of EoL products is the information on products put on the market. Unfortunately, no reliable time series on national sales are available for most of the products addressed below. For some, time series are available for market penetration but estimates are needed to extend the years covered. For others, estimates were derived from indicators such as the percentage of household connected to electricity.

For the second step i.e., the calculation and prediction of the volumes of EoL products, the life time considered is crucial. With a dedicated life time and the normal distribution (Gauss distribution) the EoL products are considered.

For the calculation of the products put on the market, the assumed stock volume of the respective product currently in use is used as the starting point for this calculation. The changes in stock as well as the products which reached EoL in the previous year are considered in the number of products put on the market.

This approach for which the results are displayed for example in Figure 4, provides robust and plausible figures. Even if the exact figures might not match with other models, they can give the reader an idea of the order of magnitude of expected EoL product quantities arising.

2.2.1. Mobile phones

In this report, the term mobile phones is used for classical mobile phones as well as smart phones. In 2012, the number of mobile subscribers per 100 inhabitants reached 116.94 (MCIT, ICT indicator 2013). For the calculation of the number of mobile phones in use , take the following factors into account, and consequently deduct 10% from the total number of subscriptions:

- Prepaid SIM cards4 out of use5
- SIM cards for data line (internet-access only)
- mobile phones that operate on dual SIM cards
- and temporary cellular line for foreign travellers in Egypt

We make the assumption that SIM-cards are not owned by anyone who does not have a mobile phone. This assumption could be improved by consulting mobile phone companies; however there was no access to this information.

It is estimated that the average life time of a mobile phone is around ten[6] years, based on local experience and considering the saturation down to the lower income groups[7]. In Egypt, mobile phones are passed to family members or friends and also hoarded at home like in industrial countries. Furthermore, mobile phones are often repaired when parts are broken which extends their life time. One part of the mobile phone is the battery which is projected separately. It is assumed that the original battery and the spare battery of a mobile phone have a life time of four years each (estimation Oeko-Institut). This life time is estimated to be a conservative assumption.

The projection of the future penetration of mobile phones is largely determined by the likely assumption that mobile phone communication will continue to be seen as a basic necessity offering numerous social and economic opportunities. Taking into account the fact that the number of mobile phones in use in Egypt exceeds the number of inhabitants already today, market saturation is almost reached.

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4 SIM cards are easy to register with a passport number and cost around 10 Egyptian Pounds (around 1 Euro)

5 SIM cards which have been out of use for 3 months are automatically unsubscribed

6 The life time of a mobile phone in Egypt is assumed to be longer than in Ghana (life time in Ghana 6 years) due to smaller import quantities for used mobile phones in Egypt. According to GSMA, 2006 the average life time of a mobile phone is around 7 years and the average time a person uses their mobile phone is around 18 months to 24 months (http://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/environmobilelifecycles.pdf)

7 To verify this estimation it is an opportunity to check the sales of spare batteries.

For this projection, it is estimated that market saturation is reached once the penetration rate reaches 1.2 mobile phones / inhabitant[8]. In Egypt, this penetration rate is expected for 2018. After this, the number of mobile phones in use is assumed to grow in parallel with the population (around +1.0 - 1.4 % per year).

In order to estimate the weight of the end-of-life mobile phones in Egypt, an average product weight of 110 g (80 grams for a mobile phone without battery, 30 grams for the mobile phone battery) was used for the period under review until 2025 (estimation Oeko-Institut). However, the on-going trend towards smartphones leads to increasing product weights[9]. For the sake of simplification, this trend is already reflected in the projection by using an average product weight of 110 g.

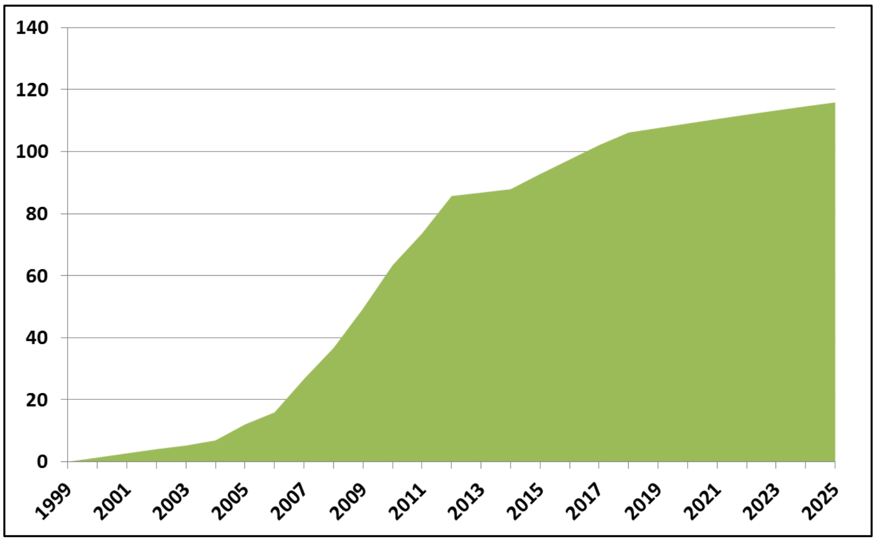
The detailed assumptions of the mobile phone calculations and projections are given in the Annex.

Figure 3 shows the stock of mobile phones in use. A steadily increasing volume of mobile phones in use is projected until the projected market saturation is reached in 2018. By the end of the review period, the numer of mobile phones in use is projected to increase to about 115 million. The number of EoL mobile phones is given in Figure 4 and Figure 5. While Figure 4 shows the projection of end-of-life mobile phones per year until 2025, Figure 5 gives the cumulative number of EoL devices until 2025. The annual number of EoL mobile phones is currently projected to increase strongly. After the market saturation in 2018, the number of EoL mobiles is projected to be around 10 million EoL mobiles per year. A significant effect in the reality is the hoarding of EoL mobiles at home or in repair shops. So currently an unexploited potential can be expected.

8 The same as in Ghana and industrial countries

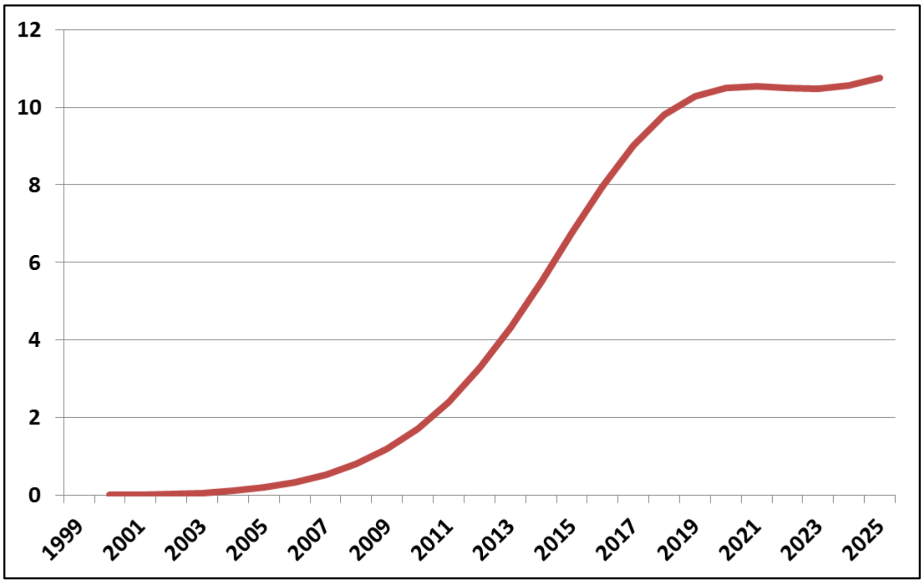
9 A study on smartphones conducted by Manhart et al. (2012) lists weights of 67 current smartphone models ranging from 98 g to 195 g without charger. The average model weight is 134 g.

Figure 3 **Projection of number of mobile phones in use in Egypt from 1999 to 2025 [in millions]**



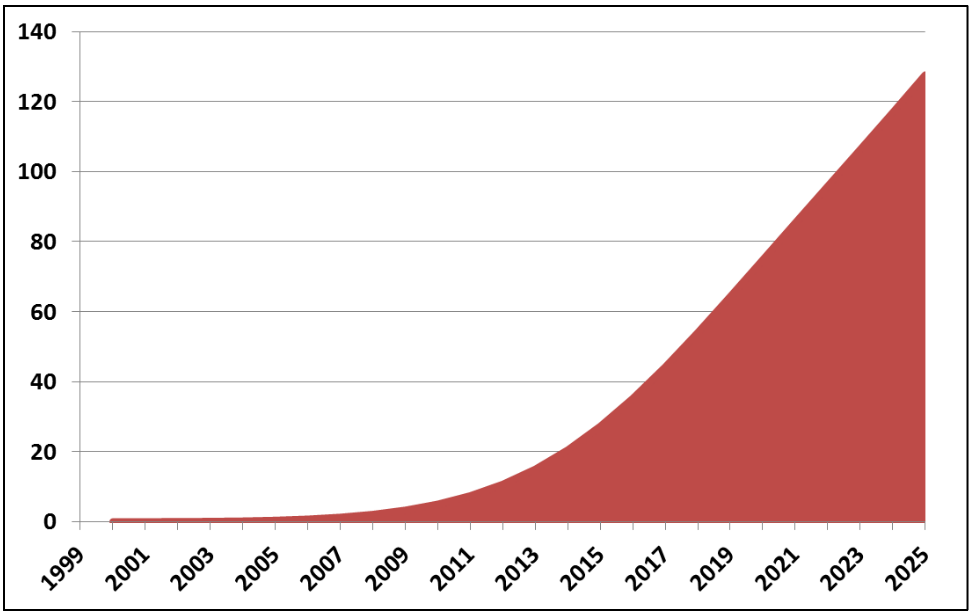
Source: Projections by Oeko-Institut

Figure 4 **Projection of number of EoL mobile phones per year in Egypt from 1999 to 2025 [in millions]**



Source: Projection by Oeko-Institut

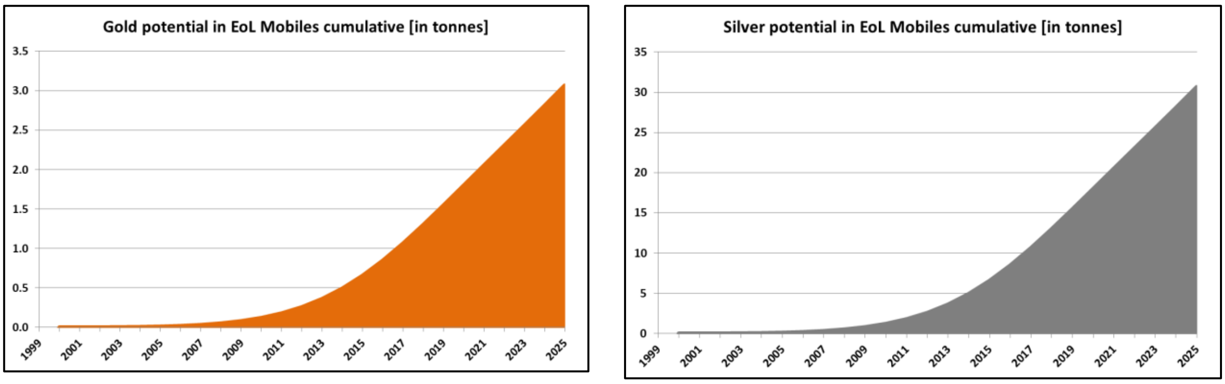
Figure 5 **Projection of cumulative number of EoL mobile phones per year in Egypt from 1999 to 2025 [in millions]**



Source: Projections by Oeko-Institut

The projected cumulative potential of gold and silver in EoL mobile phones is shown in the following figures. It is assumed that one average EoL mobile phone contains 0.24 grams of silver (~2180 ppm) and 0.024 grams of gold (~220 ppm), mainly in the circuit boards.[10] The projected cumulative potential of gold from EoL mobile phones is 3 tonnes by 2025. For comparison, the Egyptian gold holding in 2012 amounted to 75.6 tonnes. The cumulative silver potential from mobile phones is projected to reach 31 tonnes by 2025.

Figure 6 **Projected cumulative potential of gold and silver in EoL mobile phones [in tonnes]**



Source: Projections by Oeko-Institut

[10] It should be noted that the precious metal contents can vary between different models of mobile phones. The mentioned contents are based on the experience of the project partners.

For this projection, potential behavioural change triggered by the introduction of new products (e.g. smartphones) has not been considered. However, it should be pointed out that product life times may be shorter than projected due to product obsolescences, a factor which could be further investigated by communicating with network operators.

Table 5 gives estimated and projected volumes of mobile phones in use as well as the numbers and weights of EoL mobile phones and the metal potentials for 2010, 2012, 2015, 2020 and 2025. Furthermore, the mobile phone batteries are listed. The assumptions for the calculations are given in the Annex. Furthermore the quatities of mobile phone batteries and their cobalt potentials are listed.

Table 5 **Estimated and projected volumes of mobile phones* in use and at end-of-life in Egypt**

	2010	2012	2015	2020	2025
Mobile phones in use [number of devices]	63.4 million	85.7 million	92.8 million	109.1 million	115.9 million
EoL mobile phones [number of devices] per year	1.7 million	3.3 million	6.8 million	10.5 million	10.8 million
EoL mobile phones [weight excl. battery] per year	138 t	262 t	540 t	841 t	860 t
EoL mobile phones excluding battery cumulative	402 t	856 t	2 181 t	5 987 t	10 213 t
Gold in EoL mobile phones without battery, cumulative	0.12 t	0.26 t	0.65 t	1.80 t	3.06 t
Silver in EoL mobile phones without battery, cumulative	1.21 t	2.57 t	6.54 t	17.96 t	30.64 t
Palladium in EoL mobile phones without battery, cumulative	0.06 t	0.13 t	0.33 t	0.90 t	1.53 t
EoL mobile phone batteries [number of devices] per year	11 million	18 million	22 million	27 million	28 million
EoL mobile phone batteries [weight] per year	337 t	530 t	671 t	801 t	841 t
EoL mobile phone batteries [weight] cumulative	1 064 t	2 030 t	3 964 t	7 653 t	11 758 t
Cobalt in EoL mobile phone batteries [weight] cumulative	128 t	244 t	476 t	918 t	1 411 t

* all figures without chargers

Further assessment of the relevance of precious metals can be found in the attached presentation (Interim Results Egypt, November 2013).

2.2.2. Desktop PCs & Notebooks

In 2012, around 50 % (Egypt ICT indicators 2013) of the Egyptian households were equipped with at least one computer (desktop PC or notebook). On this basis, we assume that a minimum of 9.6 million computers were used in Egyptian households in 2012. Furthermore it is estimated that around 2.9 million (in 2012) computers in offices etc. were used. Approximately further 10 000 computers were in use in internet shops[11].

Over the course of the research project,different data on households using a computer in 2009 were collected (see Table 6).

Table 6 Different data for households using a computer in 2009

Proportion households using computers (2009)	Computers in hh in use (2009) [calculated with ITU hh]	Computers in offices in use (2009) [Estimation Oeko-Institut with CAPMAS data]	Computers in use in total (2009)
43.9% [MCIT, 2013]	**8.0 million**	**2.7 million**	**10.7 million**
13.1% [MCIT, 2009]	2.4 million		5.1 million
31.0% [ITU 2012]	5.7 million		8.4 million

Source: Compilation Oeko-Institut

The following projections and calculations are based on MCIT, 2013 data (further details of the calculation and assumptions is given in Annex).

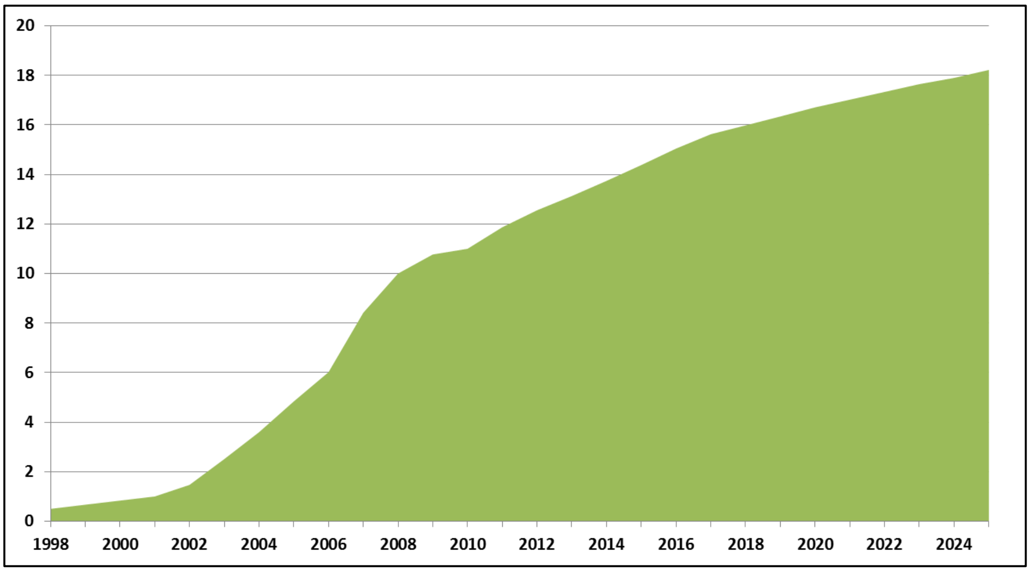
Unlike in Ghana (life time 4 years) in Egypt it is assumed that the average desktop PC as well as notebook life time is longer with around ten years due to less import of used devices and to set the assumption conservative.[12]

The projection of the time series of the total number of computers (desktops as well as notebooks) in use in stock is shown in Figure 7 below. Considering the above mentioned criteria, it can be estimated that the total in-use-stock of computers in Egypt was 11.0 million in 2010. Furthermore, this data allows estimating the number of computers (notebooks and desktops) in use in stock in 2011 (11.9 million).

[11] It was assuemd that there are 5 computers in each of the ~ 2 000 internet shops in Egypt

[12] It was assumed that avused Pentium 4 computers (4-5 years old) with monitor, keyboard, mouse is about 500-800 Egyptian Pound (70-100Euro); a used notebook (4-5 years old) is about 2 000 Egyptian Pound (around 280 Euro)

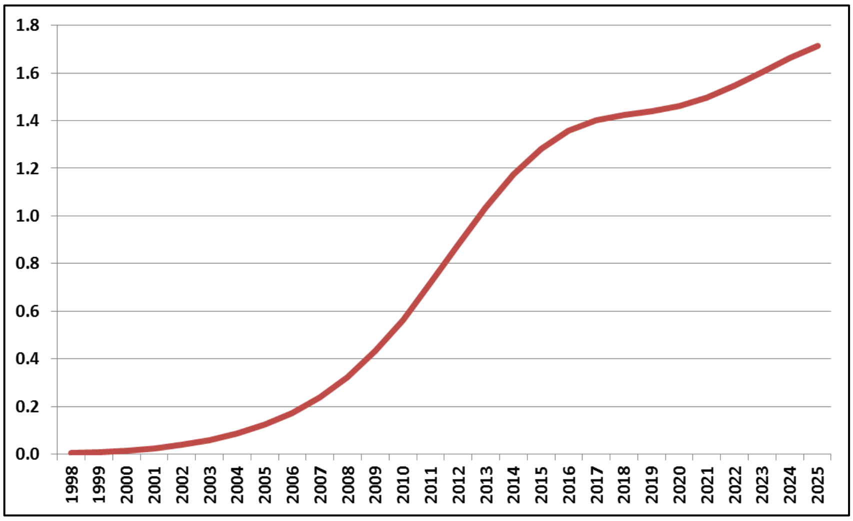
Figure 7 **Projection of the number of computers (desktops and notebooks) in use in Egypt from 1998 to 2025 [in millions]**



Source: Projections by Oeko-Institut

Figure 8 gives an overview of the projected annual quatities of EoL computers arising in Egypt. Notebooks and desktop PCs are included in the total number of computers.

Figure 8 **Projection of the number of EoL computers per year in Egypt from 1998 to 2025 [in millions]**



Source: Projections by Oeko-Institut

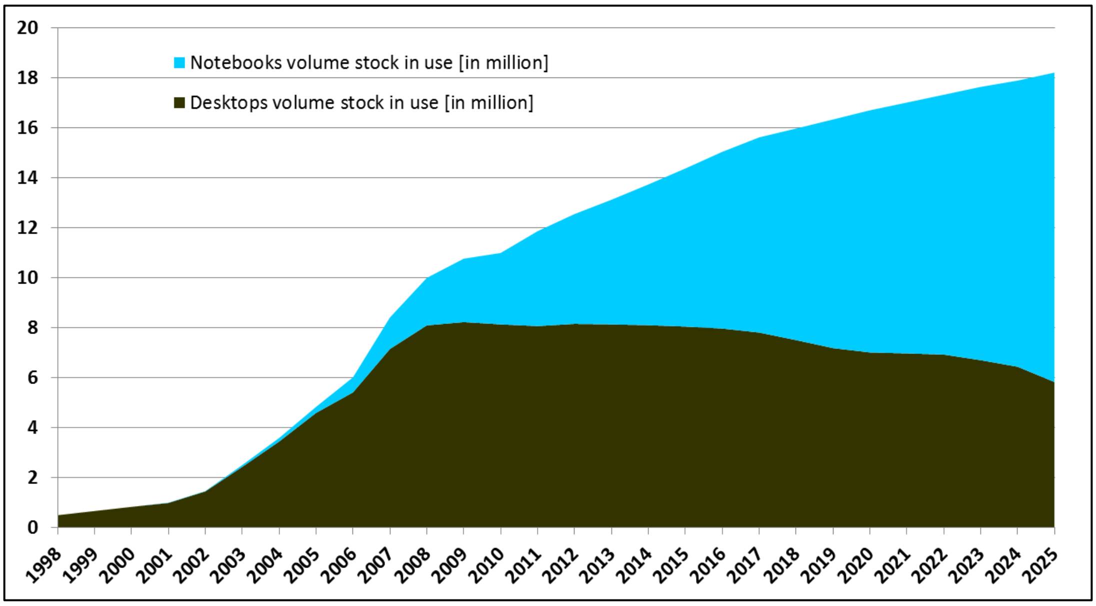
To estimate the number of notebooks in use and at end-of-life, it is assumed that the market-share of notebooks steadily increases, starting at 1 % in 2001 (development see Figure 9). The figures provided for notebooks include tablets.

The future penetration of desktop PCs and notebooks is quite uncertain, as developments are driven by various highly variable factors such as technological trends in the ICT-sector, price levels as well as the economic developments in Egypt. Nevertheless, the future development of the desktop PCs and notebooks in use (installed number of devices) was modelled, based on the following assumptions:

- The linear growth will continue for some years until it is steadily slowing down.
- Despite the rapidly growing economy, the share of households equipped with at least one computer will not reach the saturated levels in industrialised countries (75-90%) within the next 20 years. It is assumed that in 2025, 60% of the Egyptian households will be using a computer (assumption by Oeko-Institut).
- In parallel to global developments, notebooks will experience an increasing market share in the future. According to the model presented here, it will reach 68 % in 2025.
- It is assumed that desktop PCs and notebooks will continue to be the dominant hardware computing systems in the next decades – despite the fact that client-server systems, cloud computing and tablet PCs are gaining increasing importance worldwide. This decision was taken in order to reduce modelling complexity13.

[13] The aim of this modelling exercise is to estimate the end-of-life volumes and resource potential from computing systems in Egypt. As thin clients and tablet PCs have a comparable material composition as desktop PCs and notebooks, these technological trends are – from a material perspective – partly covered in the modelling exercise.

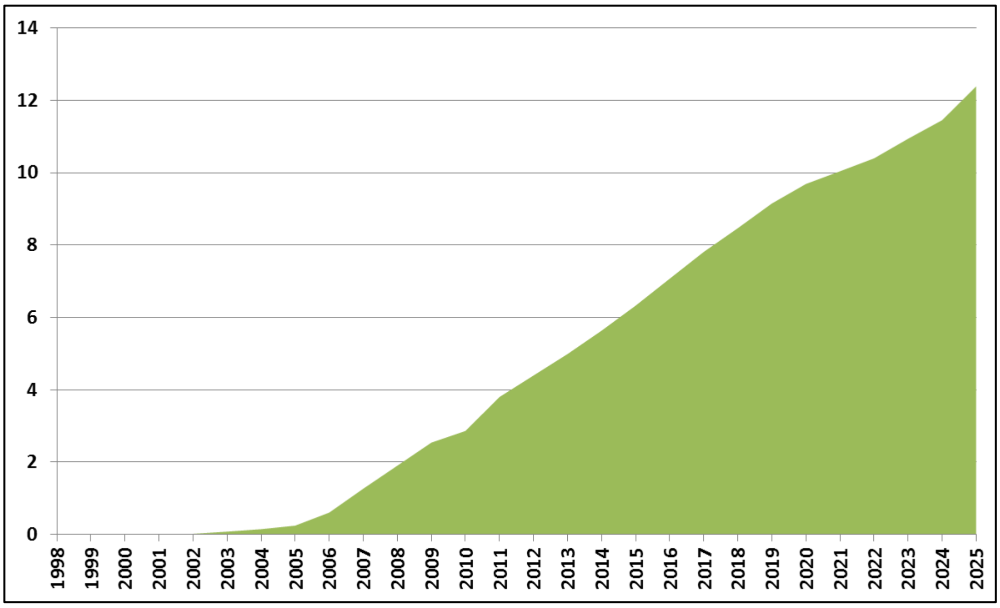
Figure 9 **Projection of the number of desktop PCs and notebooks in use in Egypt [in millions]**



Source: Projections by Oeko-Institut

Figure 10 shows the number of notebooks in use (in stock). Based on the increasing market share of notebooks, the need to replace EoL notebooks as well as the growing proportion of households using a computer, the number of notebooks is increasing constantly.

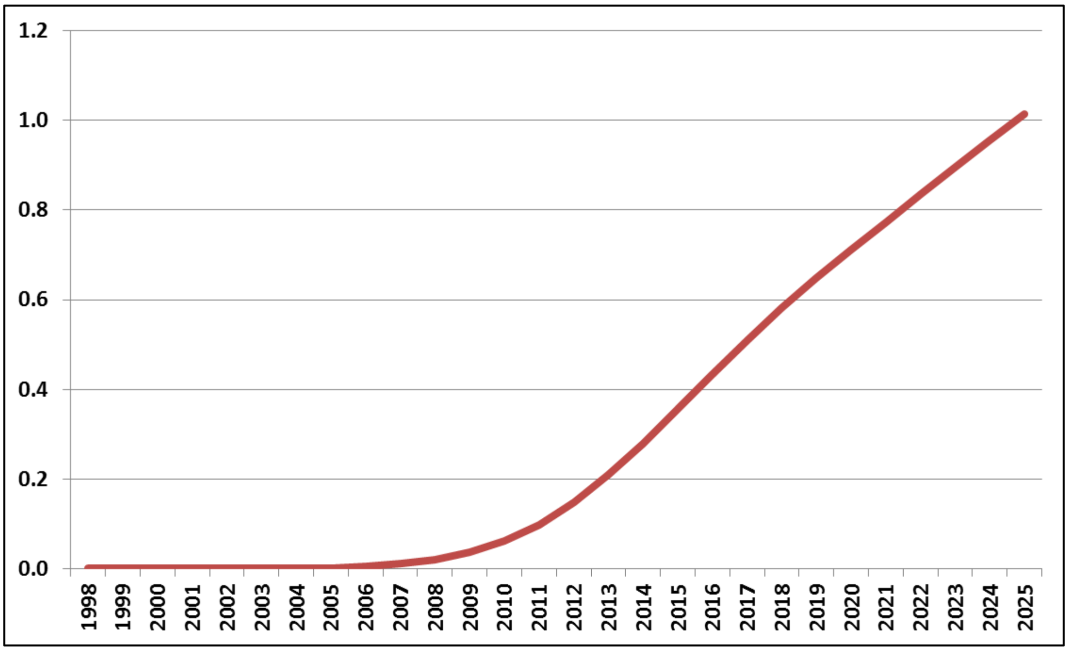
Figure 10 **Projection of the number of notebooks in use in Egypt from 1998 to 2025 [in millions]**



Source: Projections by Oeko-Institut

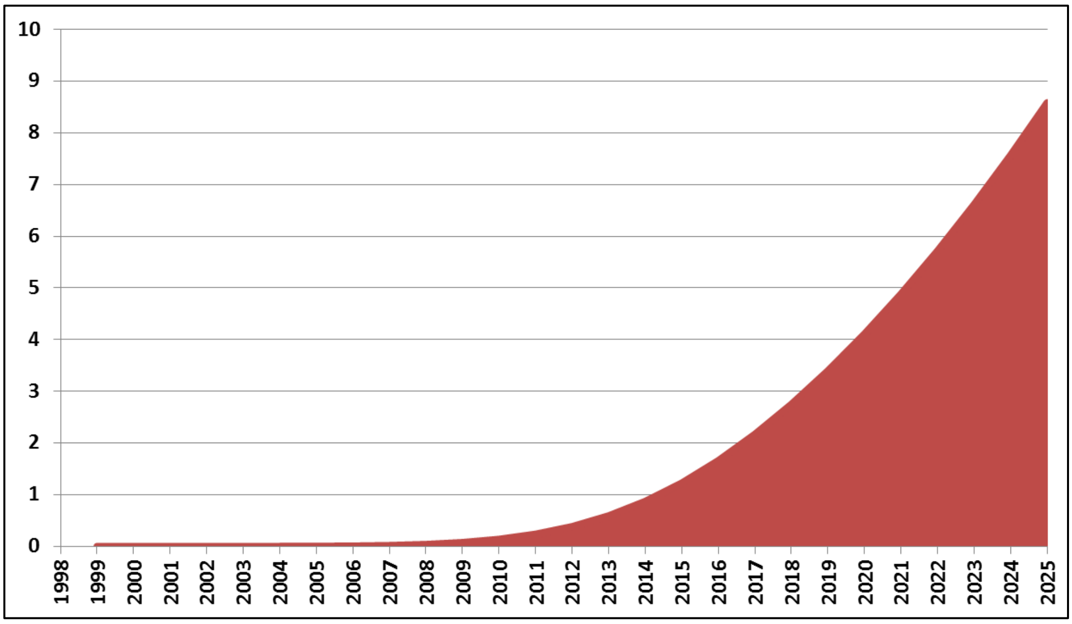
For notebooks, the first relevant number of EoL devices occurs in 2011 with around 100 000 pieces (see Figure 11). Figure 11 shows the projected annual number of EoL notebooks while Figure 12 gives the projected cumulative number of EoL notebooks until 2025. The yearly number of EoL notebooks is projected to increase to 1 million around 2025. As for the mobile phones, it is assumed that EoL notebooks are staying in people's homes beyond the period of use.

Figure 11 Projection of the number of EoL notebooks per year in Egypt from 1998 to 2025 [in millions]



Source: Projections by Oeko-Institut

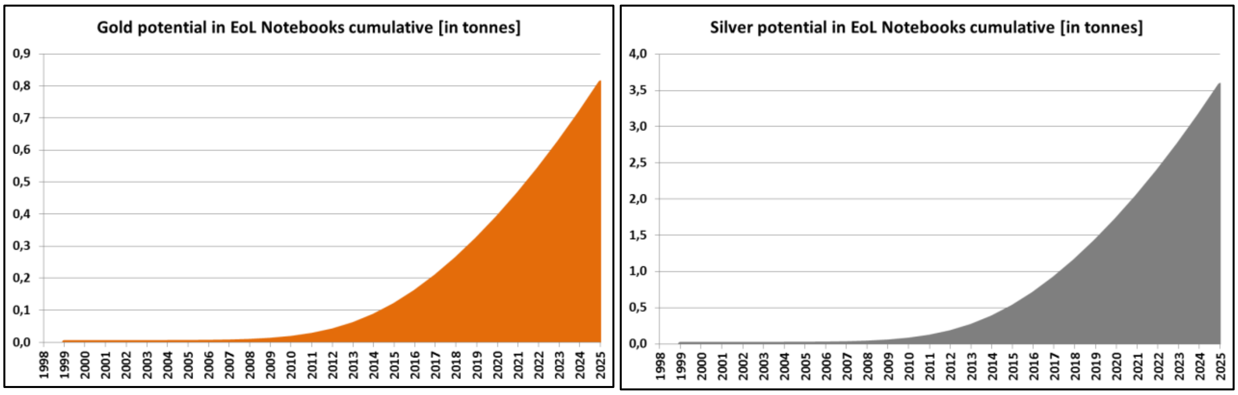
Figure 12 Projection of the cumulative number of EoL notebooks in Egypt from 1998 to 2025 [in millions]



Source: Projections by Oeko-Institut

The projected cumulative potential of gold and silver in EoL notebooks is shown in the following figures. It is assumed that each EoL notebook contains 0.094 grams of gold and 0.416 grams of silver, mainly in the circuit boards. Until 2025, the cumulative potential of gold from EoL notebooks is projected at 0.8 tonnes, the cumulative potential of silver at 3.6 tonnes.

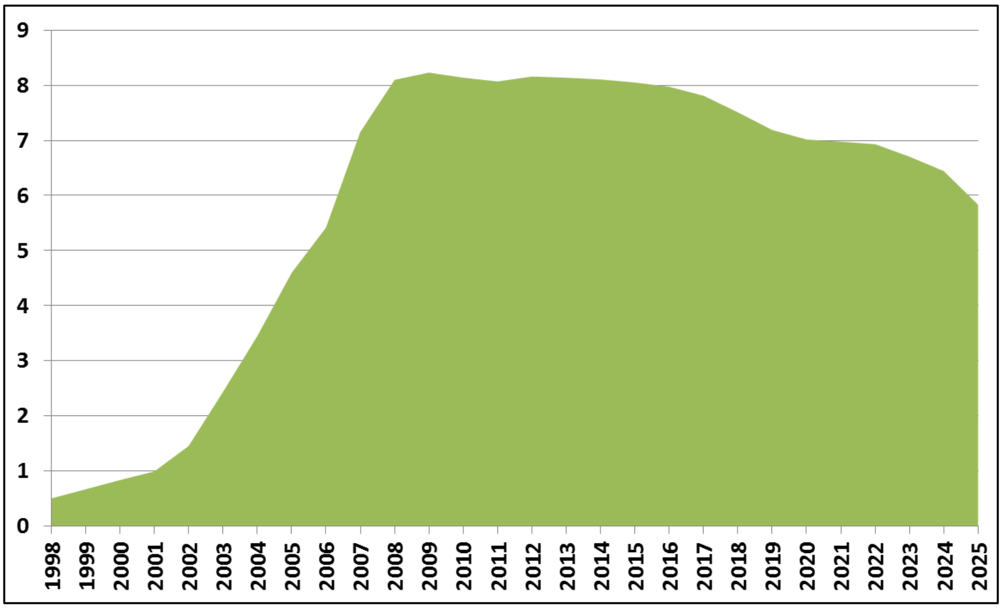
Figure 13 Projected cumulative potential of gold and silver in EoL notebooks



Source: Projections by Oeko-Institut

As shown in Figure 9, the share of desktops is projected to decrease. Figure 14 shows that According to the projection, the market saturation for desktops has already been reached (in 2008), and the number of desktops in use will keep decreasing until 2025.

Figure 14 **Projection of the number of desktops in use in Egypt from 1998 to 2025 [in millions]**

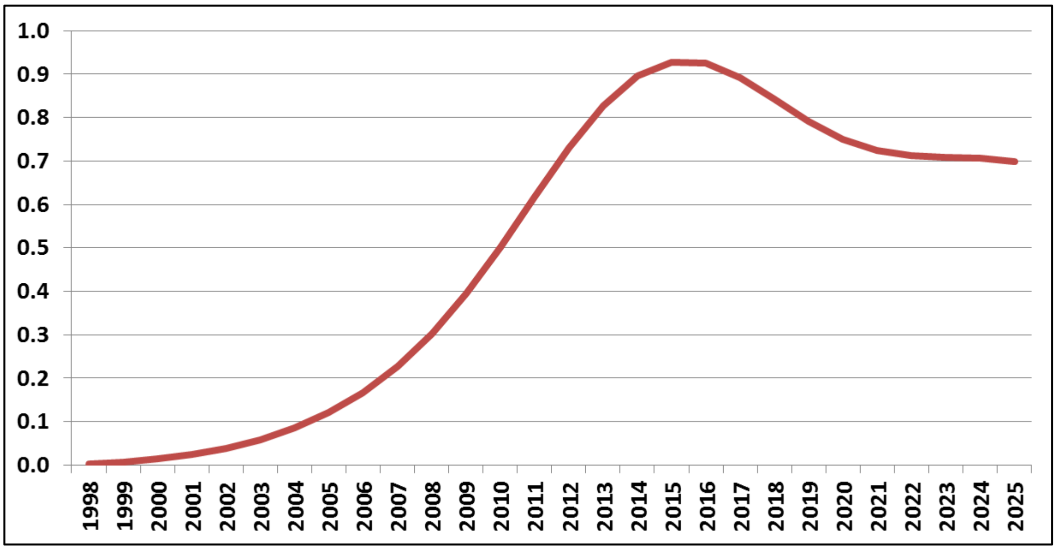


Source: Projections by Oeko-Institut

It is projected that in the beginning of the century the first amounts of EoL desktop PCs has been occurred (see Figure 15). The projection shows the maximum number of annual EoL desktops in 2015 / 2016. Afterwards the number of EoL devices arising each year is projected to decrease.

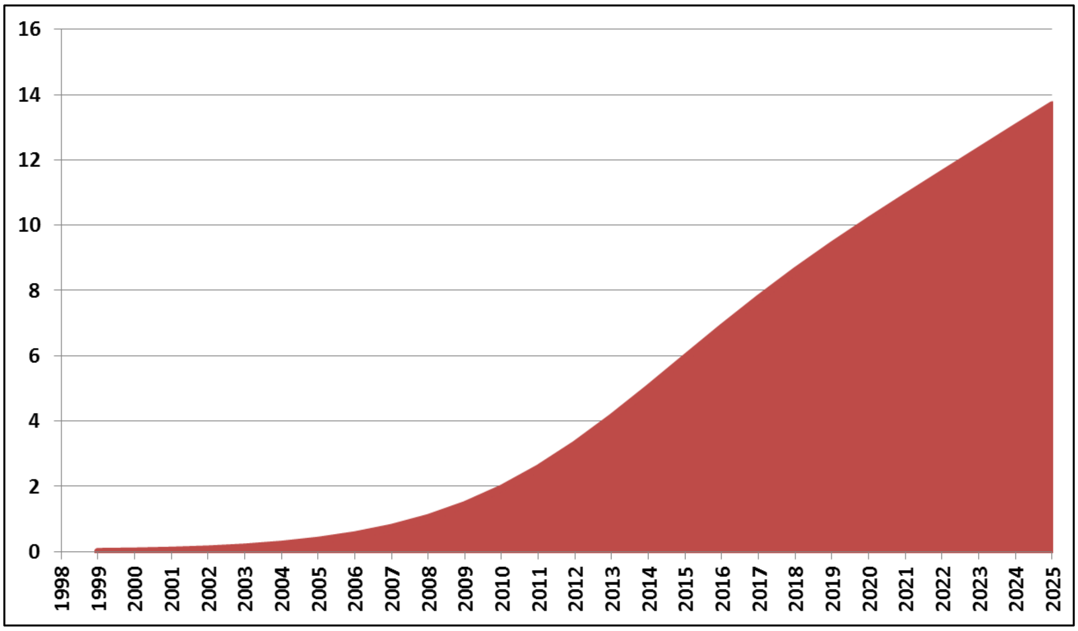
The cumulative view of EoL desktops is given in Figure 16 below. Although the market saturation has already been reached, it is projected that the majority of desktops will enter the EoL market in the future due to the life time of 10 years.

Figure 15 **Projection of the number of EoL desktops per year in Egypt from 1998 to 2025 [in millions]**



Source: Projections by Oeko-Institut

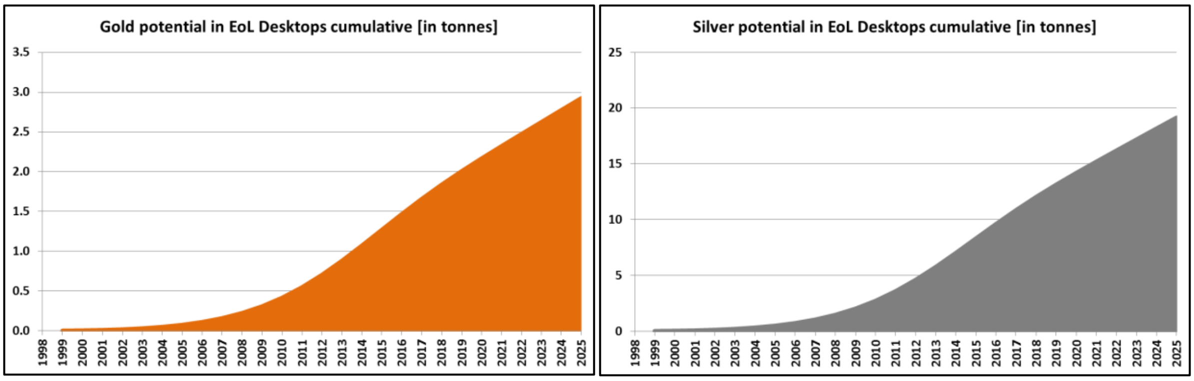
Figure 16 **Projection of the cumulative number of EoL desktops in Egypt from 1998 to 2025 [in millions]**



Source: Projections by Oeko-Institut

The projected cumulative potential of gold and silver in EoL desktops is shown in the following figures. It is assumed that each EoL desktop contains 0.214 grams of gold and 1.398 grams of silver, mainly in the circuit boards. In the Annex, more details are provided.

Figure 17 Projected cumulative potential of gold and silver in EoL desktops [in tonnes]



Source: Projections by Oeko-Institut

To project the total weight of the end-of-life desktop PCs and notebooks in Egypt, average product weights of 8 kg (desktop computers) and 2.5 kg (notebooks) were assumed. However, the on-going trend to miniaturisation refleceted in ultra-slim notebooks and compact desktop PCs will lead to gradually declining average product weights.

In Table 7, data for the years 2010, 2012, 2015, 2020 and 2025 are shown for the total number of desktop PCs and notebooks in use in stock. Figure 7 and Figure 9 are based on these number of devices in stock. The other figures in the table below refer to the number of EoL devices arising per year (see also Figure 8, Figure 10, Figure 11) or the weight of EoL computers per year. The detailed assumptions for the calculation can be found in the Annex.

Table 7 **Estimated and projected volumes of desktop PCs and notebooks in use and at end-of-life in Egypt**

	2010	2012	2015	2020	2025
Desktop PCs in use [number of devices]	8.1 million	8.2 million	8.1 million	7.0 million	5.8 million
Notebooks in use [number of devices]	2.9 million	4.4 million	6.3 million	9.7 million	12.4 million
EoL desktop PCs [number of devices] per year	0.50 million	0.73 million	0.93 million	0.75 million	0.70 million
EoL notebooks [number of devices] per year	0.06 million	0.15 million	0.36 million	0.71 million	1.01 million
EoL desktop PCs [weight without monitor & peripherals] per year	4 018 t	5 842 t	7 425 t	6 001 t	5 593 t
EoL notebooks [weight without peripherals] per year	155 t	369 t	888 t	1 779 t	2 535 t
EoL desktop PCs [weight without monitor & peripherals] cumulative	15 587 t	26 368 t	47 571 t	81 180 t	109 567 t
EoL notebooks [weight without peripherals] cumulative	346 t	961 t	3 066 t	10 275 t	21 461 t
Gold in EoL desktops, cumulative	0.41 t	0.70 t	1.27 t	2.17 t	2.92 t
Silver in EoL desktops, cumulative	2.72 t	4.60 t	8.31 t	14.18 t	19.14 t
Palladium in EoL desktops, cumulative	0.19 t	0.32 t	0.59 t	1.00 t	1.35 t
Gold in EoL notebooks, cumulative	0.01 t	0.04 t	0.12 t	0.39 t	0.81 t
Silver in EoL notebooks, cumulative	0.06 t	0.16 t	0.51 t	1.71 t	3.57 t
Palladium in EoL notebooks, cumulative	0.01 t	0.01 t	0.05 t	0.16 t	0.33 t

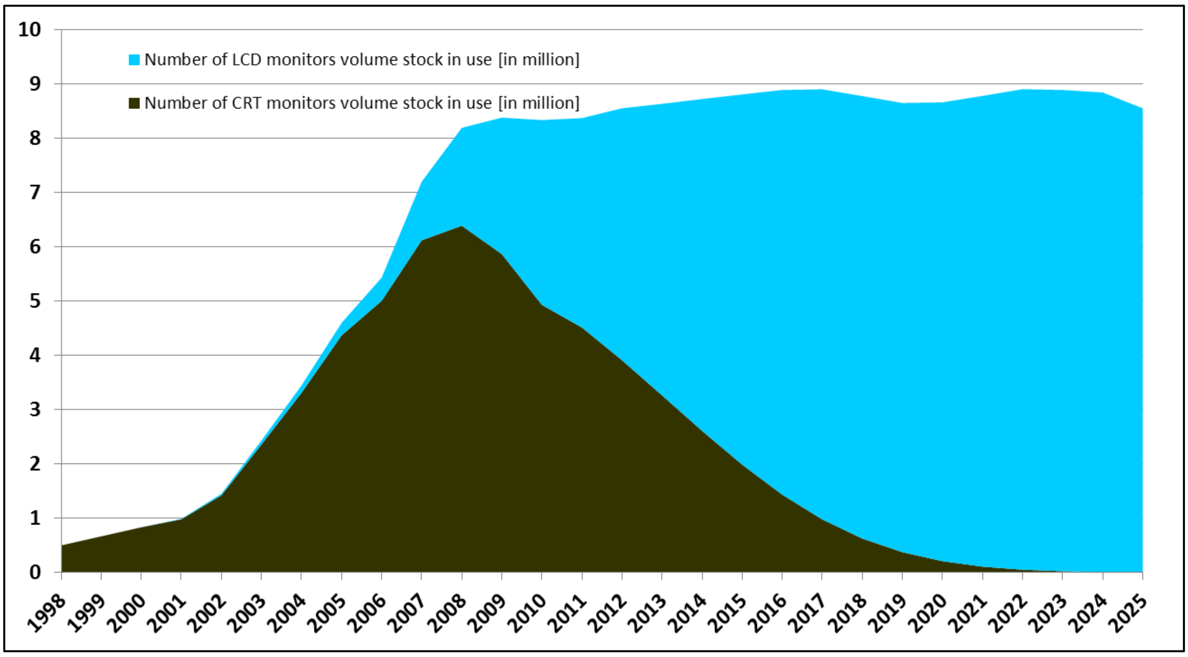
Further assessment of the relevance of precious metals is displayed in the attached presentation (Interim Results Egypt, November 2013).

2.2.3. CRT & LCD monitors

For the projection of the number of monitors (LCD as well as CRT), it is assumed that each desktop PC is equipped with one monitor with a comparable life time for LCD as well as for CRT[14] monitors (ten[15] years).[16] Furthermore, it is assumed that 10%[17] of all notebooks are used with additional stand-alone-monitors (e.g. via docking-station) in 2013. As notebooks will gain increasing importance also in office use, it is assumed that this share will rise to 22% until 2025 (estimation Oeko-Institut).

Regarding the split between CRT monitors and LCD monitors, it is assumed that in 2005, around 5% of the in use of monitors in Egypt are LCD monitors. For the projection it is further assumed that only LCD monitors will enter the market after 2009. The modeling of the respective share is illustrated in Figure 18 below. In this figure the sum of CRT and LCD monitors is displayed; hence, the top of the blue area represent the total amount of monitors (LCD and CRT monitors).

Figure 18 Projection of the number of LCD and CRT monitors in use in Egypt [in millions]



Source: Projections by Oeko-Institut

14 Reportedly, an unknown number of CRTs still functioning were rebuilt for use as TV

15 In Ghana, 4 years is assumed to be the life time of one monitor due to high import rates of second-hand products into Ghana. According to a Plasma TV Buying Guide the life time of a Plasma display is around 20 000 – 30 000 hours and 50 000 – 60 000 hours for LCD TVs. It is assumed that the screens lose their brightness after this time period.

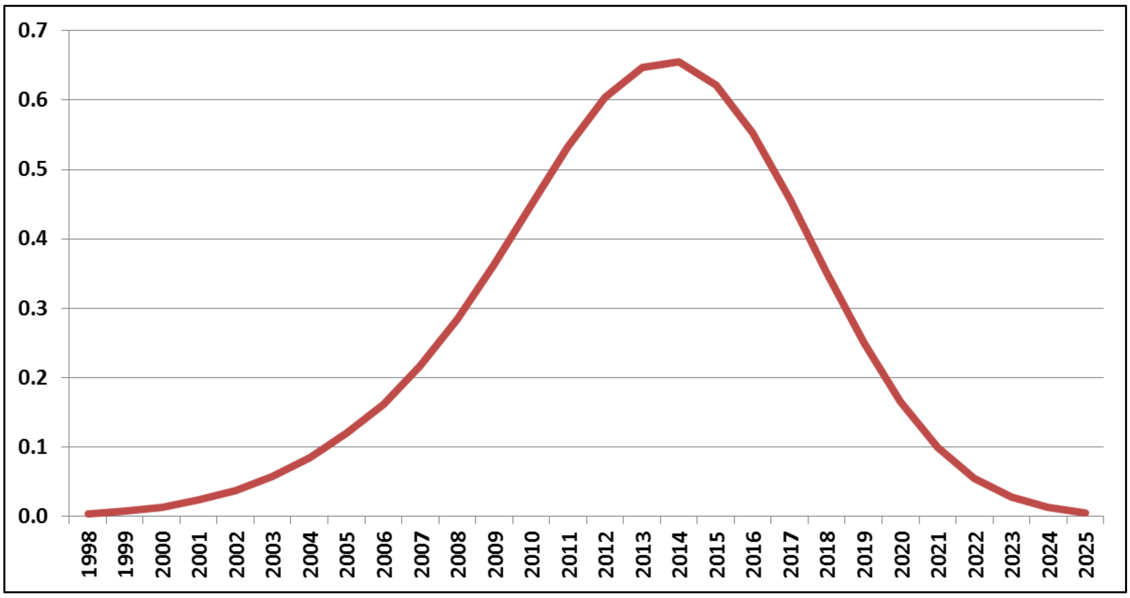
16 Additional information: one CRT monitor (used for up to 4 years) costs <100 Egyptian Pounds (<15 Euro); older monitors (older than 4 years) are given away or private hoarded in private cellars etc. Furthermore, in rural areas used monitors are sometimes converted for use as TVs.

17 In the projection for Ghana, 20% of notebooks are used in conjunction with an additional monitor

It is projected that the market saturation of CRT monitors has already been reached with a strong decreasing market. LCD monitors are projected to replace the EoL CRT monitors.

The annual number of EoL CRT monitors is shown in Figure 19 below. The maximum number of EoL devices is expected in 2014 at around 650 thousand pieces.

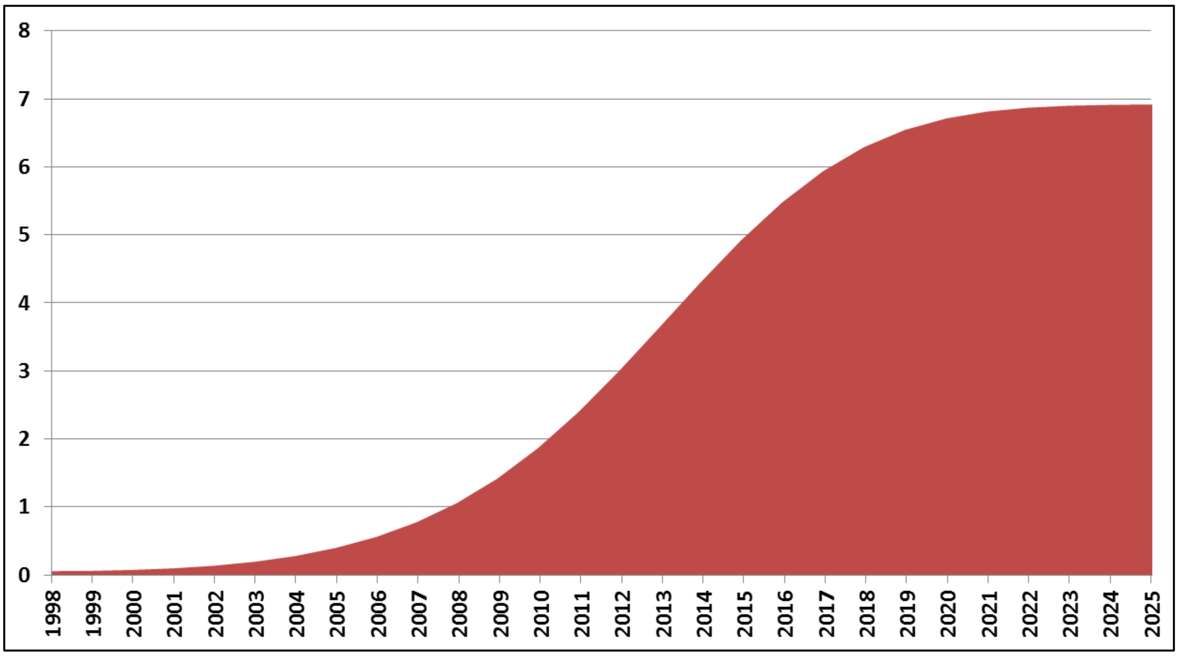
Figure 19 Projection of the number of EoL CRT monitors per year in Egypt [in millions]



Source: Projections by Oeko-Institut

The projected cumulative number of EoL CRT monitors is shown in Figure 20 below. The cumulative amount illustrates the total amount of EoL CRT monitors in case that none device was dismantled, exported or lost in waste before.

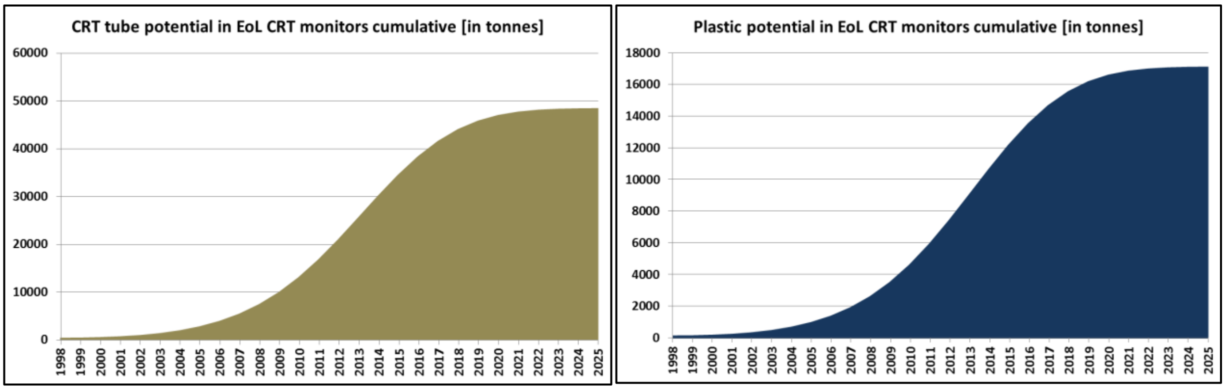
Figure 20 Projection of the cumulative number of EoL CRT monitors [in millions]



Source: Projections by Oeko-Institut

The projected cumulative potential of plastics and CRT tubes in EoL CRT monitors is illustrated in the following figures. It is assumed that each EoL CRT monitor contains around 2.5 kg of plastics and 7 kg of CRT tubes. By 2025, the cumulative potential of plastics from EoL CRT monitors is projected to reach 16 990 tonnes, the cumulative potential of CRT tubes is projected to reach 48 040 tonnes. Furthermore, is is assumed that each EoL CRT monitor contains 0.041 grams of gold, 0.714 grams of silver and 0.02 grams of palladium.

Figure 21 Projected cumulative potential of CRT tubes and plastics in CRT monitors [in tonnes]



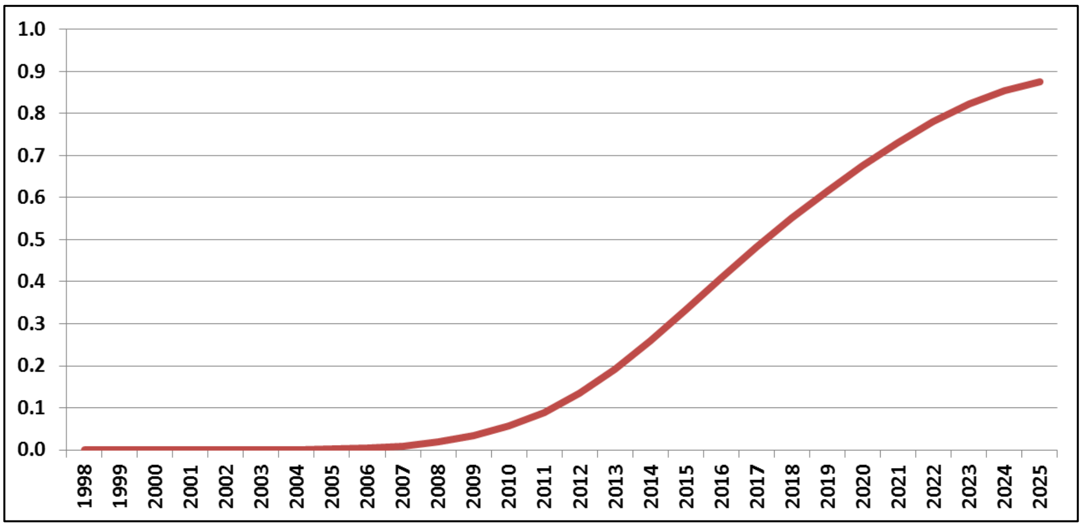
Source: Projections by Oeko-Institut

Further details on the relevance of CRT glass, plastics and precious metals in EoL CRT monitors are given in the attached presentation (Interim Results Egypt, November 2013).

As shown in Figure 18, a strong increase of the in-use LCD monitors until 2017 has been projected.

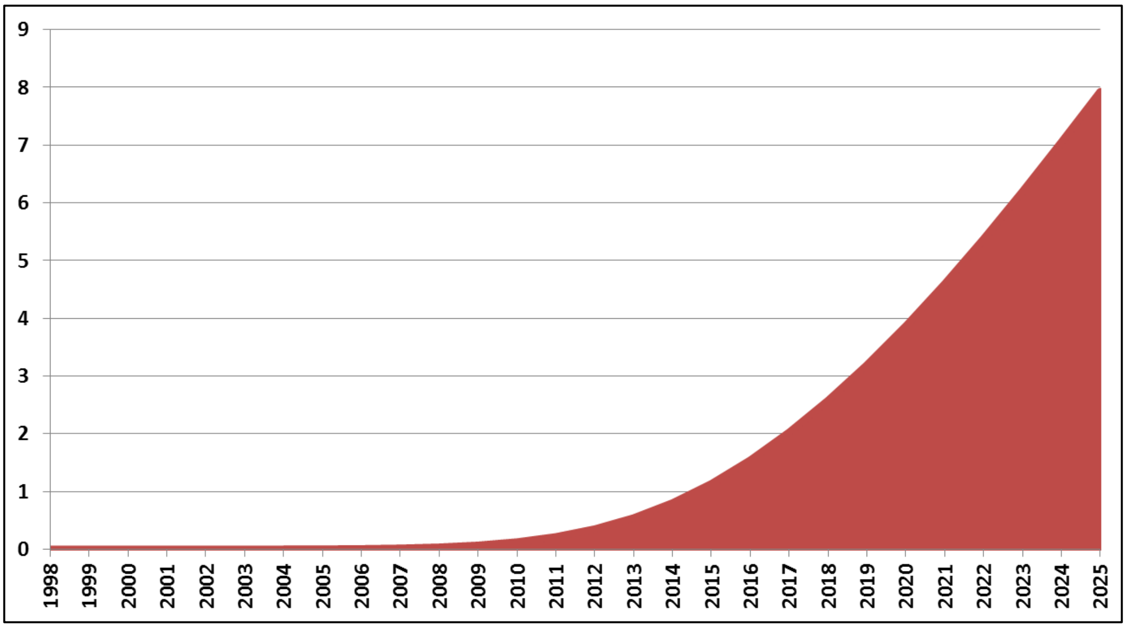
In Figure 22, the projected annual volume of EoL LCD monitors is shown. The number of EoL LCD monitors increases to 0.9 million in 2025. In the cumulative view (see Figure 23) the cumulative volume of EoL LCD monitors grows up to 8.8 million devices in 2025.

Figure 22 Projection of the number of EoL LCD monitors per year in Egypt [in millions]



Source: Projections by Oeko-Institut

Figure 23 **Projection of the cumulative number of EoL LCD monitors in Egypt [in millions]**



Source: Projections by Oeko-Institut

The estimation of the total weight of the end-of-life CRT and LCD monitors in Egypt was based on an average product weight of 14.230 kg for CRT monitors (based on Wecycling 2009) and 4.7 kg for LCD monitors (Amoyaw-Osei et al. 2011 S. 101).

In Table 8, data for the years 2010, 2012, 2015, 2020 and 2025 are given for CRT and LCD monitors.

The detailed assumptions for the calculation can be found in the Annex.

Table 8 **Estimated and projected volumes of CRT and LCD monitors in use and at end-of-life in Egypt.**

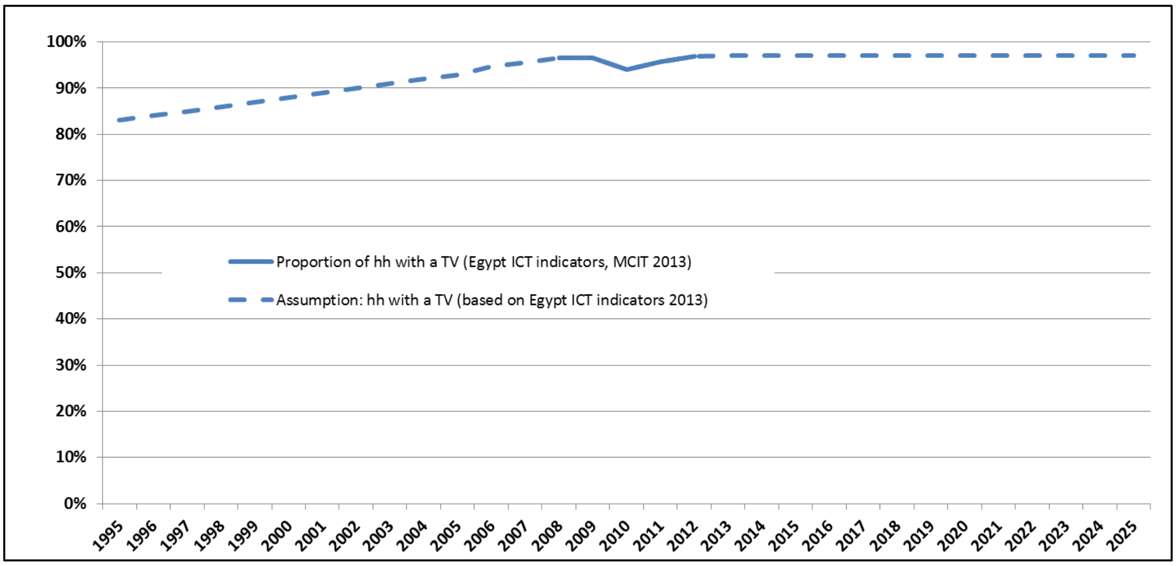
	2010	2012	2015	2020	2025
CRT monitors in use [number of devices]	4.93 million	3.91 million	1.99 million	0.21 million	0 million
LCD monitors in use [number of devices]	3.41 million	4.64 million	6.82 million	8.45 million	8.55 million
EoL CRT monitors [number of devices] per year	0.45 million	0.60 million	0.62 million	0.17 million	0.01 million
EoL LCD monitors [number of devices] per year	0.06 million	0.13 million	0.33 million	0.67 million	0.87 million
EoL CRT monitors [weight] per year	6 382 t	8 588 t	8 845 t	2 351 t	78 t
EoL LCD monitors [weight] per year	265 t	633 t	1 567 t	3 171 t	4 112 t
EoL CRT monitors [weight] cumulative	26 002 t	42 172 t	69 550 t	94 835 t	97 723 t
EoL LCD monitors [weight] cumulative	593 t	1 647 t	5 337 t	18 185 t	37 273 t
Plastic in EoL CRT monitors cumulative [weight]	4 510 t	7 324 t	12 087 t	16 487 t	16 990 t
CRT tube in EoL CRT monitors cumulative [weight]	12 753 t	20 709 t	34 178 t	46 619 t	48 039 t

2.2.4. TVs

According to MCIT data (MCIT, Egypt ICT indicators 2013), 94 % of the households or 17.486 million households in Egypt were equipped with at least one TV in 2010. The time series generated with these data (see Figure 24 below) shows a high level in ownership of TVs. The dotted line is an assumption of the time series based on the MCIT data. It is assumed that market saturation is reached when 97% of households are equipped with at least one TV. Market saturation has already been reached in 2012.[18] Unlike in Ghana, 99% of Egyptian households are connected to the electricity system (AfDB 2010) which is the reason that in 2010 just 52% of households were equipped with a TV in Ghana and 94% of Egyptian households were equipped with a TV.

18 For comparison: In Germany, 96% of households are equipped with at least one TV (destatis 2013)

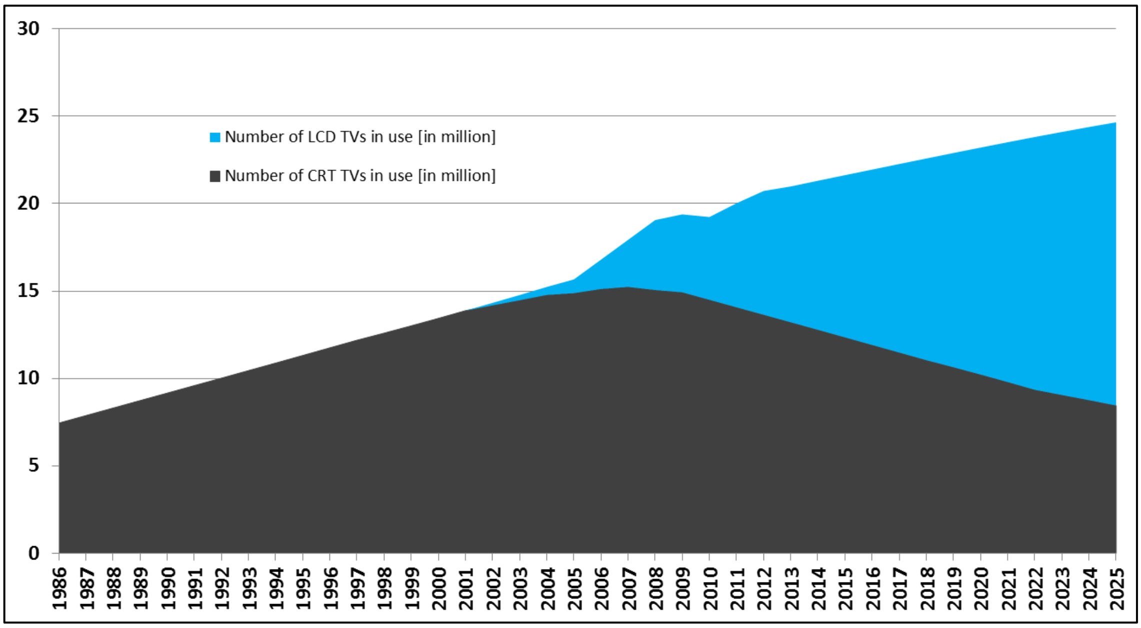
Figure 24 Share of Egyptian households owning at least one TV



Generally, it is assumed that the total number of installed TVs exceeds the number of households with TVs by 10% (assumption by Oeko-Institut). These additional 10% are mainly TVs installed in bars, restaurants, hotels and offices as well as in households owning more than one TV.[19] The projection of the total number of TVs (CRT as well as LCD TVs) is shown in Figure 25 below.

[19] For comparison: In Ghana an additional 20% is assumed for TVs in bars, restaurants, hotels, offices due to the lower market penetration in Ghana.

Figure 25 **Projection of the number of TVs (CRT and LCD TVs) in use in Egypt from 1986 to 2025 [in millions]**



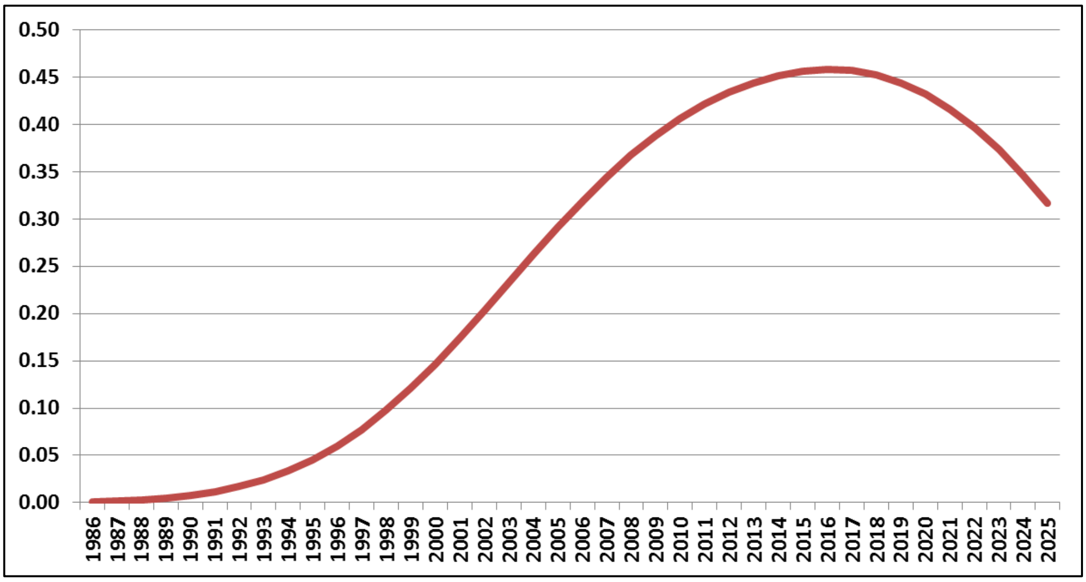
Source: Projections by Oeko-Institut

Furthermore, an average life time of LCD TVs of 10 years is used for the calculations and 20 years for CRT TVs[20]. For the split between CRT TVs and flat-screen TVs, it has been assumed that the transition to flat screens will take considerable longer than in the computer monitor segment, due to longer life spans of CRT TVs. Unlike in Ghana, it is assumed that the majority of TVs in Egypt are no second-hand products.

It is assumed that in 2009, the last CRT TVs were put on the market. Based on a 20-year product life time with a normal distribution, the following quantities of EoL CRT TVs are projected to arise each year (see Figure 26).

[20] For comparison: For Ghana, an average life time of 10 years has been assumed for both CRT and LCD TVs. According to a Plasma TV Buying Guide the life time of a Plasma display is around 20 000 – 30 000 hours and 50 000 – 60 000 hours for LCD TVs. It is assumed that the screens lose their brightness after this time period. Depending on the share of TV sets in use in households (useful time around 10 years) or Service Centers (useful time 7 years) the average life time differs.

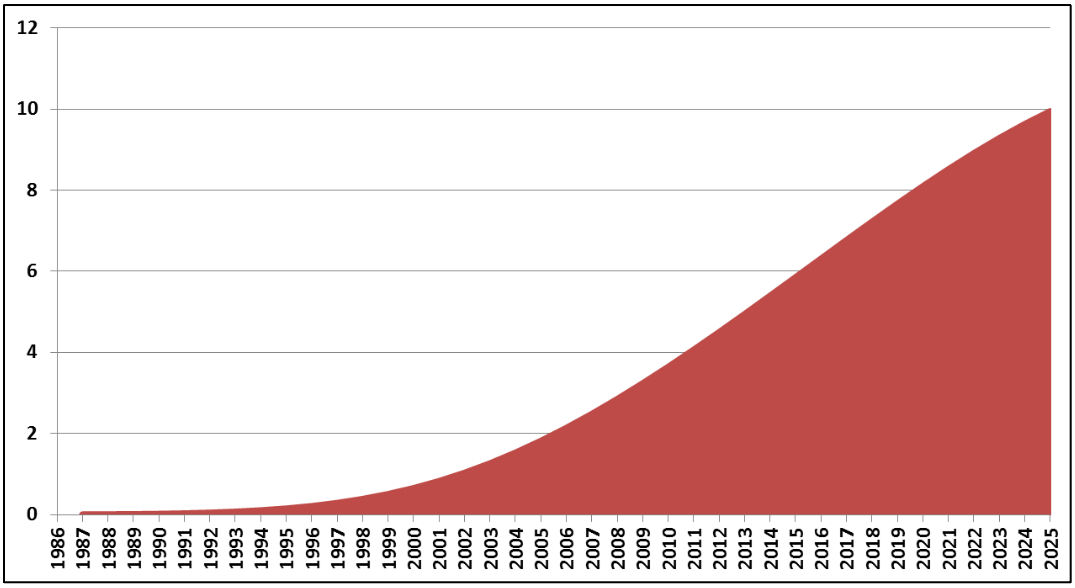
Figure 26 **Projection of the number of EoL CRT TVs per year in Egypt from 1986 to 2025 [in millions]**



Source: Projections by Oeko-Institut

The cumulative volume of EoL CRT TVs is shown in Figure 27.

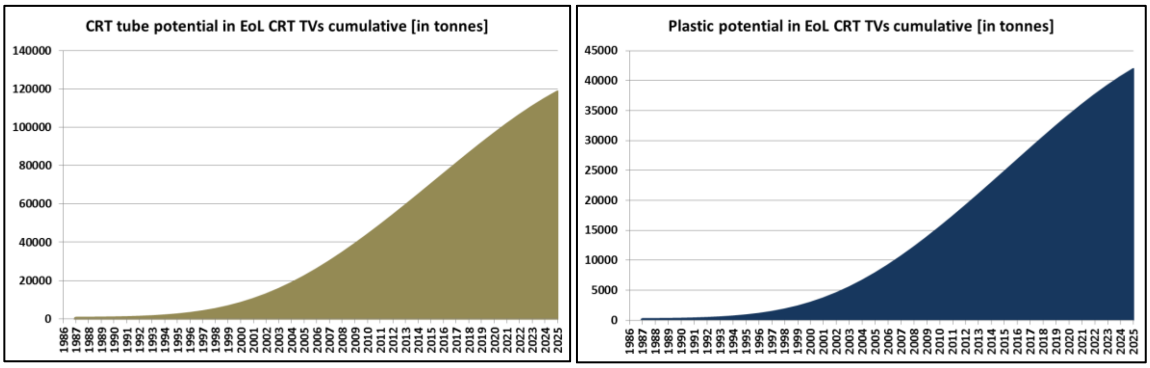
Figure 27 **Projection of the cumulative number of EoL CRT TVs in Egypt from 1986 to 2025 [in millions]**



Source: Projections by Oeko-Institut

It is assumed that one CRT TV contains around 4.2 kg of plastics, a CRT tube of around 11.9 kg as well as 0.07 grams of gold, 1.2 grams of silver and 0.035 grams of palladium. The whole CRT TV is assumed to weigh 14.23 kg. In Figure 28, the projected potential of CRT tubes and plastics in EoL TVs is shown.

Figure 28 Projected cumulative potential of CRT tubes and plastics in EoL CRT TVs in Egypt from 1986 to 2025 [in tonnes]

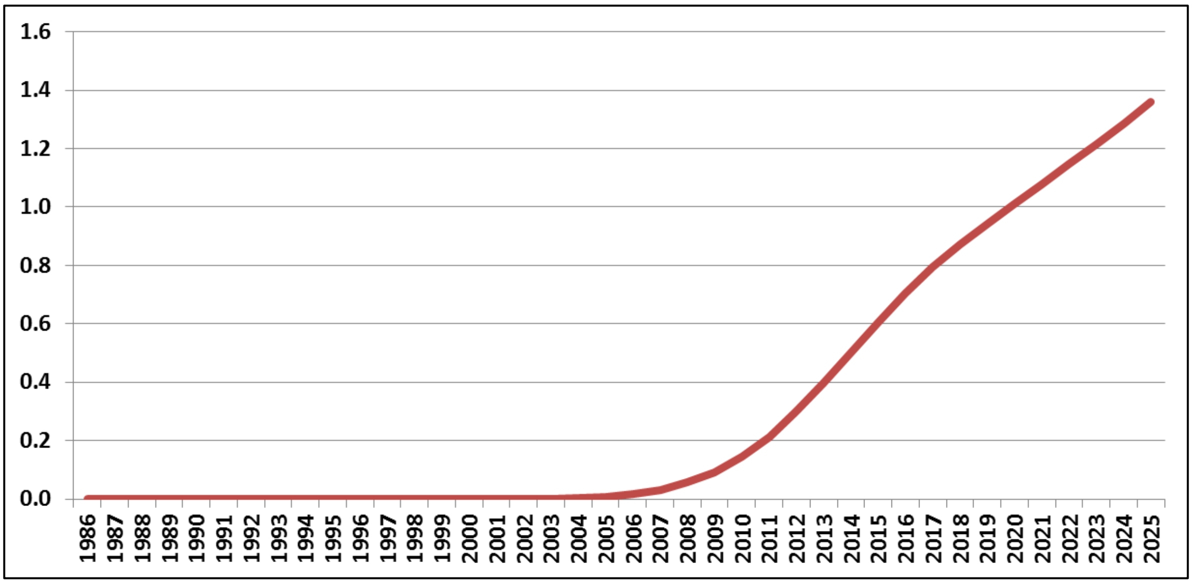


Source: Projections by Oeko-Institut

Further details on the recycling potential of CRT glass, plastics and precious metals in EoL CRT TVs can be found in the attached presentation (Interim Results Egypt, November 2013).

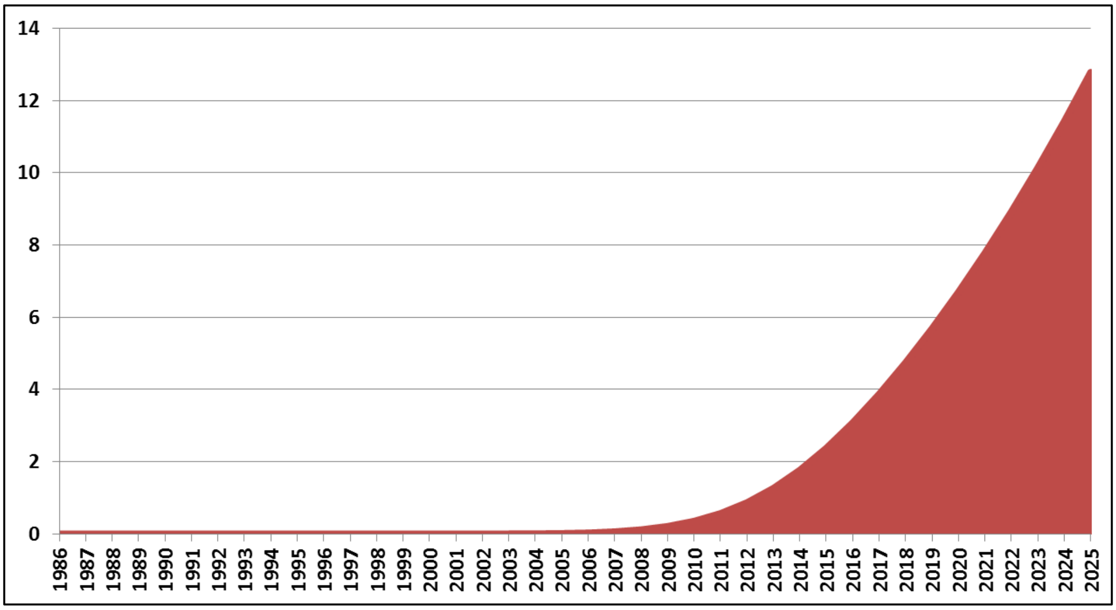
For LCD TVs, a life time of 10 years is assumed with a market entry around 2001. The number of LCD TVs in use is shown in Figure 25. The projected EoL LCD TVs are shown in Figure 29 (number arising each year) and Figure 30 (cumulative potential).

Figure 29 Projection of the number of EoL LCD TVs per year in Egypt from 1986 to 2025 [in millions]



Source: Projections by Oeko-Institut

Figure 30 Projection of the cumulative number of EoL LCD TVs in Egypt from 1986 to 2025 [in millions]



Source: Projections by Oeko-Institut

The average product weights are assumed to be 24.14 kg for CRT TVs (Wecycling 2009) and 15 kg for flat-screen TVs (Manhart et al. 2011, Amoyaw-Osei et al. 2011).

Table 9 shows the numbers of CRT and LCD TVs in use for the years 2010, 2012, 2015, 2020 and 2025, as well as the numbers and weights of EoL devices.

The detailed assumptions for the calculation and projection are given in the Annex.

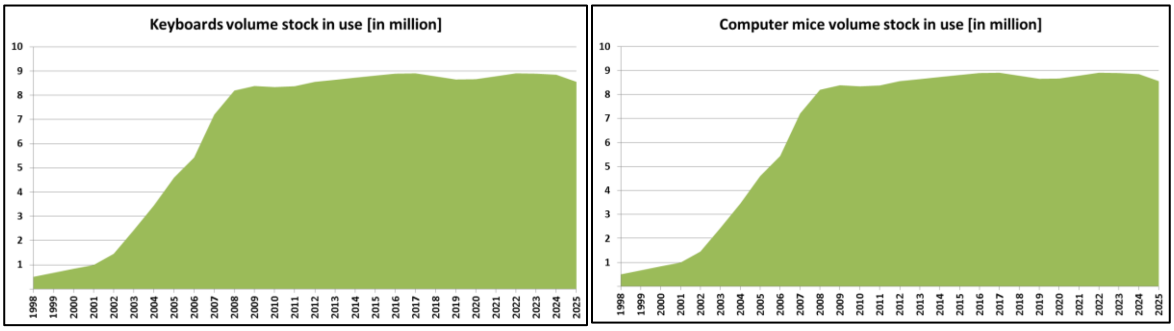
Table 9 Estimated and projected volumes of CRT and flat-screen TVs in use and at end-of-life in Egypt

	2010	2012	2015	2020	2025
CRT TVs in use [number of devices]	14.50 million	13.64 million	12.35 million	10.23 million	8.46 million
Flat-screen TVs in use [number of devices]	4.74 million	7.08 million	9.28 million	12.98 million	16.20 million
EoL CRT TVs per year [number of devices]	0.41 million	0.43 million	0.46 million	0.43 million	0.32 million
EoL flat screen TVs per year [number of devices]	0.14 million	0.30 million	0.61 million	1.01 million	1.36 million
EoL CRT TVs per year [weight]	9 803 t	10 480 t	11 018 t	10 436 t	7 654 t
EoL flat screen TVs per year [weight]	2 159 t	4 492 t	9 107 t	15 171 t	20 376 t
EoL CRT TVs cumulative [weight]	87 907 t	108 560 t	141 205 t	195 385 t	240 035 t
EoL LCD TVs cumulative [weight]	5 281 t	12 975 t	35 588 t	100 464 t	191 769 t
Plastic in EoL CRT TVs, cumulative	15 296 t	18 889 t	24 570 t	33 997 t	41 766 t
CRT tube in EoL CRT TVs, cumulative	43 250 t	53 411 t	69 473 t	96 129 t	118 097 t
Gold in EoL CRT TVs, cumulative	0.25 t	0.31 t	0.40 t	0.56 t	0.69 t
Silber in EoL CRT TVs, cumulative	4.41 t	5.45 t	7.09 t	9.80 t	12.04 t
Palladium in EoL CRT TVs, cumulative	0.13 t	0.16 t	0.20 t	0.28 t	0.34 t

2.2.5. Keyboards and computer mice

For modelling purposes, it is assumed that each desktop PC is equiped with one keybord and one mouse Furthermore, it is anticipated that in 2012, 10% of the notebooks (same percentage as for additional monitors for notebooks) were operated with a keyboard and a mouse. The projected number of keyboards and computer mice in use is shown in the following figure (Figure 31).

Figure 31 **Projection of the number of keyboards and computer mice in use in Egypt from 1998 to 2025 [in millions]**

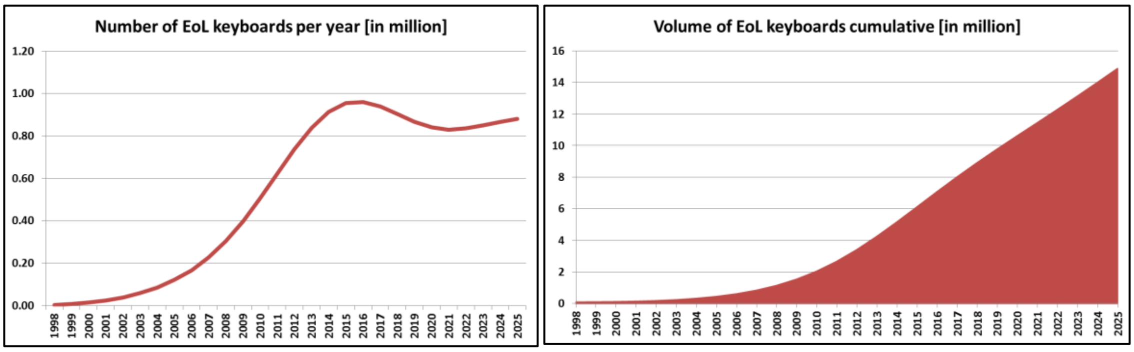


Source: Projections by Oeko-Institut

An average 10-year life time is assumed for keyboards and computer mice, respectively. The average product weight of one EoL keyboard is assumed to be 1 006 grams and of one EoL computer mouse 111 grams (EoL list Bo2W project).

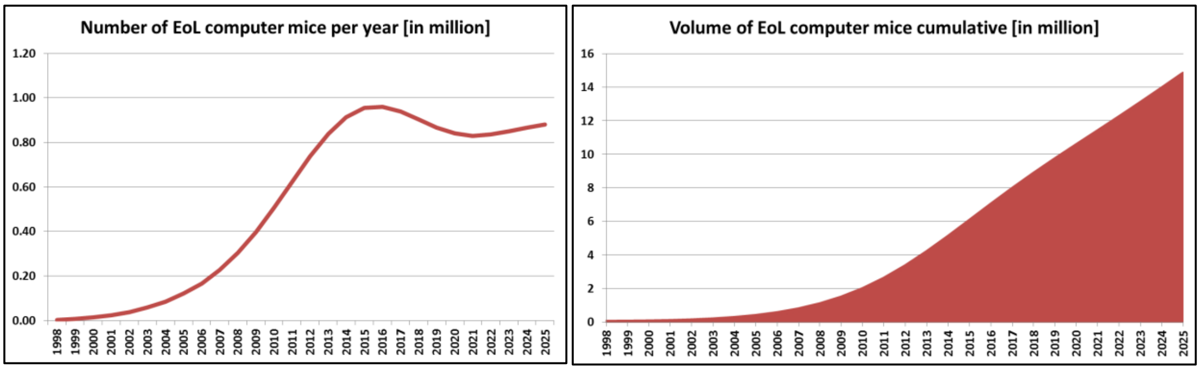
Figure 32 and Figure 33 show the the projections of the number of EoL keyboards and EoL computer mice in an annual and cumulative view.

Figure 32 **Projection of the annual and cumulative number of EoL keyboards in Egypt from 1998 to 2025 [in millions]**



Source: Projections by Oeko-Institut

Figure 33 **Projection of the annual and cumulative number of EoL computer mice in Egypt from 1998 to 2025 [in millions]**



Source: Projections by Oeko-Institut

Table 15 shows on the years 2010, 2012, 2015, 2020 and 2025 data for keyboards and computer mice in use as well as numbers and weights of the end-of-life devices.

The assumptions made for the calculations and projections are given in the Annex.

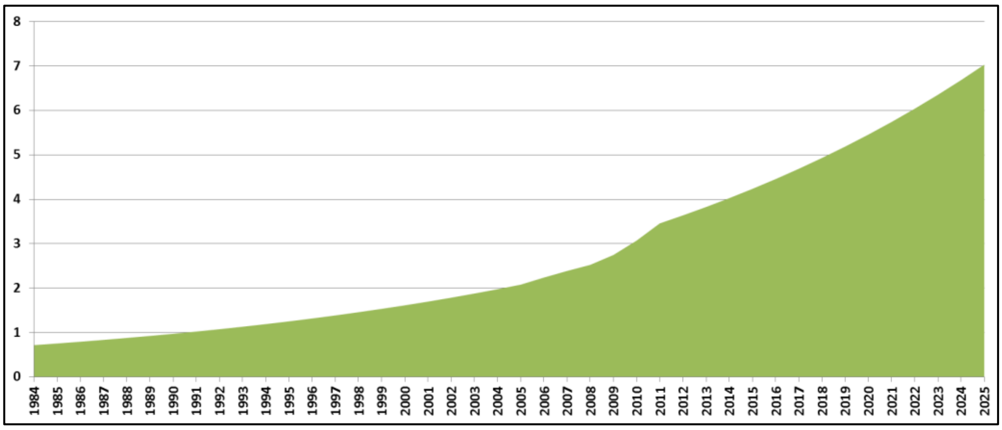
Table 10 **Estimated and projected volume of keyboards and computer mice in use and at end-of-life in Egypt**

	2010	2012	2015	2020	2025
Keyboards in use [number of devices]	8.3 million	8.6 million	8.8 million	8.7 million	8.6 million
Computer mice in use [number of devices]	8.3 million	8.6 million	8.8 million	8.7 million	8.6 million
EoL keyboards per year [number of devices]	0.50 million	0.74 million	0.96 million	0.84 million	0.88 million
EoL computer mice per year [number of devices]	0.50 million	0.74 million	0.96 million	0.84 million	0.88 million
EoL keyboards per year [weight]	508 t	743 t	961 t	845 t	886 t
EoL computer mice per year [weight]	56 t	82 t	106 t	93 t	98 t
EoL keyboards cumulative [weight]	1 965 t	3 334 t	6 059 t	10 597 t	14 887 t
EoL computer mice cumulative [weight]	217 t	368 t	669 t	1 169 t	1 643 t

2.2.6. Passenger vehicles

In 2011, 6.3 million vehicles were licensed in Egypt with a 55% share of licensed passenger vehicles. In total, 3.5 million passenger vehicles were licensed in 2011. That means, i.e. 43 passenger vehicles are licensed per 1 000 inhabitants (CAPMAS, statistical yearbook 2012). Data for licensed vehicles are available from 2005 until 2011 by CAPMAS (CAPMAS statistical yearbook 2012). The CAGR (Compound annual growth rate) of the licensed passenger vehicles in Egypt was 9.1% between 2006 and 2011.[21] Based on the growth rate projected by Mc Kinsey in 2010, around 7 million passenger vehicles will be licensed in Egypt in 2025. That means that 73 passenger vehicles will be licensed per 1 000 inhabitant (see Figure 34 below). The main agglomeration area of licensed vehicles in Egypt is the Governorate Cairo (including Helwan) with 2 Mio. vehicles in 2011. Especially in Cairo road traffic increased significantly over the last years. (CAPMAS, statistical yearbook 2012; Transport 2013)

Figure 34 Projection of the number of licensed passenger vehicles in use in Egypt from 1984 to 2025 [in millions]



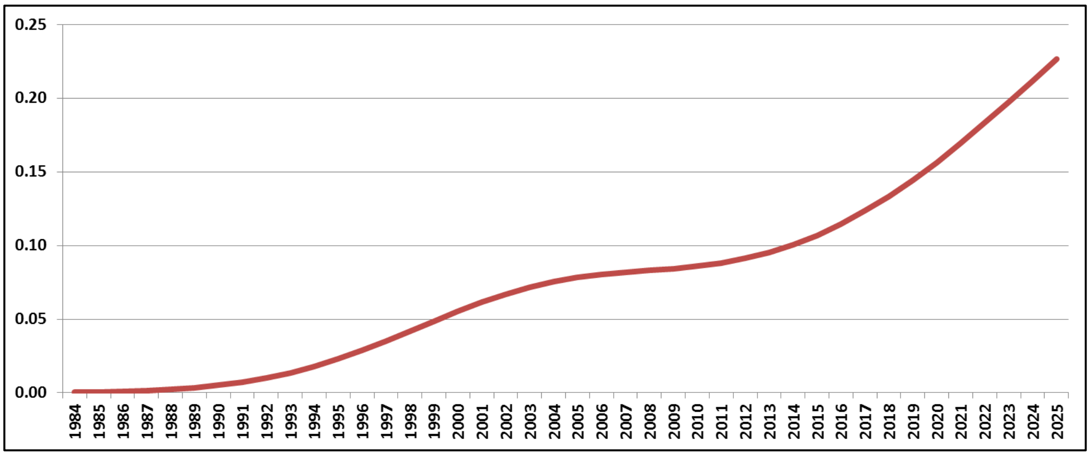
Source: Projections by Oeko-Institut

The average life time of a passenger vehicle is assumed to be 20 years.

Figure 35 and Figure 36 show the projected number of EoL licensed passenger vehicles arising per year and cumulative EoL numbers for each year.

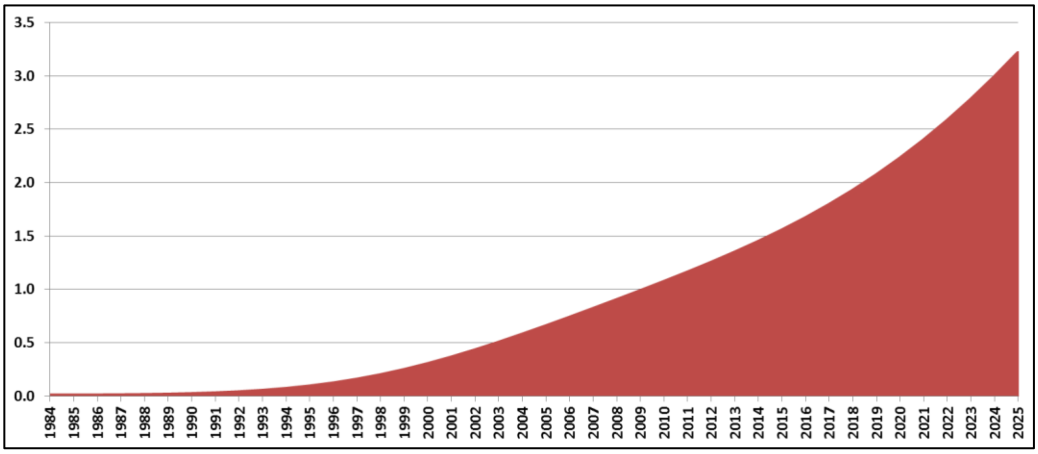
21 The sales of imported cars increased by 18% from 2012 to 2013 (18.5 thousand cars compared to 15.6 thousand cars), with an increase of cars assembled in Egypt from 10.4 to 13.9 thousand during the same period (a 34% increase) (source: Khaled al-Hosni)

Figure 35 **Projection of the number of EoL licensed passenger vehicles per year from 1984 to 2025 in Egypt [in millions]**



Source: Projections by Oeko-Institut

Figure 36 **Projection of the cumulative number of EoL licensed passenger vehicles from 1984 to 2025 in Egypt [in millions]**



Source: Projections by Oeko-Institut

Table 11 shows on the years 2010, 2012, 2015, 2020 and 2025 data for passenger vehicles in use as well as number of the EoL vehicles.

The assumptions made for the calculations and projections are given in the Annex.

Table 11 **Estimated and projected volumes of passenger vehicles in use and at end-of-life in Egypt**

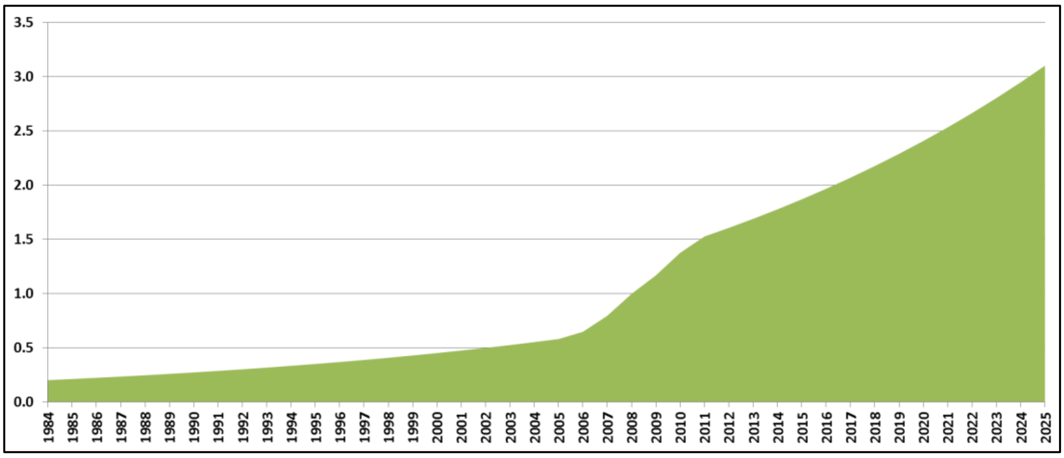
	2010	2012	2015	2020	2025
Passenger vehicles in use [number of devices]	3.07 million	3.64 million	4.03 million	5.46 million	7.03 million
EoL vehicles per year [number of devices]	0.09 million	0.09 million	0.11 million	0.16 million	0.23 million
EoL passenger vehicles cumulative [number of devices]	1.1 million	1.2 million	1.5 million	2.2 million	3.2 million

2.2.7. Motorcycles

In 2011, around 1.5 million motorcycles were licensed in Egypt. I.e. 24% of licensed vehicles in Egypt are motorcycles. The market penetration was 19 motorcycles per 1 000 inhabitants in 2011. (CAPMAS, statistical yearbook 2012)

Data for licensed motorcycles are available from 2005 until 2011 (CAPMAS statistical yearbook 2012) and a high CAGR of 18.8% (2006-2011) can be observed. For the projection until 2025, the CAGR of 5.2% by MC Kinsey was used. The number of licensed motorcycles is projected to increase to 3.1 million in 2025 (32 motorcycles per 1 000 people). The projected number of motorcycles in use from 1984 until 2025 is shown in Figure 37 below.

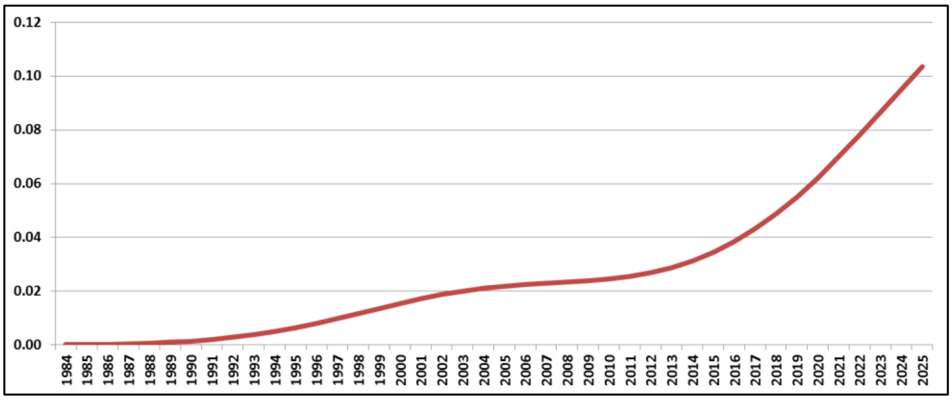
Figure 37 **Projection of the number of motorcycles in use in Egypt from 1984 to 2025 [in millions]**



Source: Projections by Oeko-Institut

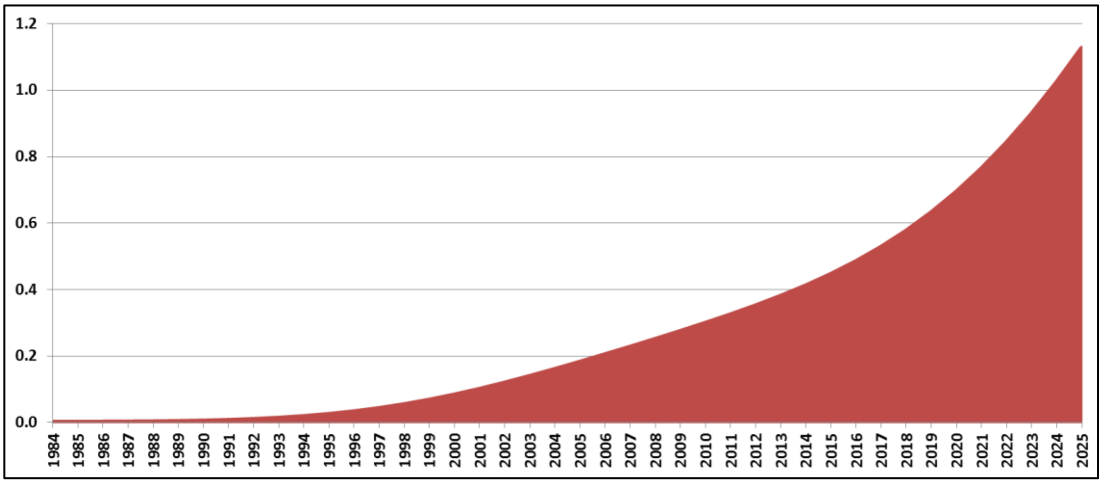
A 20-year life time has been assumed for the motorcycles. In the following figures, the number of EoL motorcycles are shown annually and cumulative.

Figure 38 **Projection of the number of EoL motorcycles per year from 1984 to 2025 in Egypt [in millions]**



Source: Projections by Oeko-Institut

Figure 39 **Projection of the cumulative number of EoL motorcycles per year from 1984 to 2025 in Egypt [in millions]**



Source: Projections by Oeko-Institut

Table 12 shows on the years 2010, 2012, 2015, 2020 and 2025 data for licensed motorcycles in use as well as the number of EoL bikes.

The assumptions made for the calculation and projection is given in the Annex.

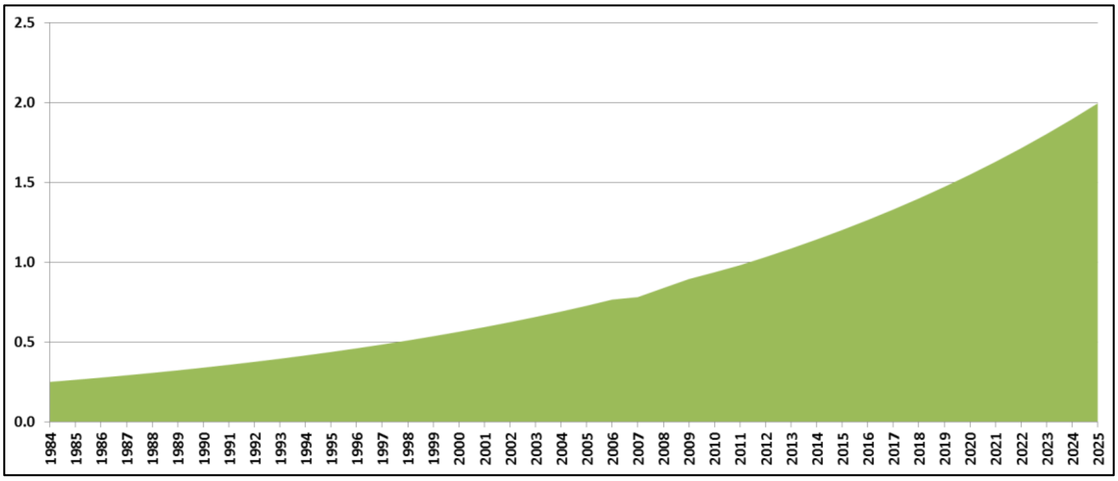
Table 12 **Estimated and projected volumes of licensed motorcycles in use and at end-of-life in Egypt**

	2010	2012	2015	2020	2025
Licensed motorcycles in use [number of devices]	1.38 million	1.61 million	1.87 million	2.41 million	3.10 million
EoL motorcycles per year [number of devices]	0.03 million	0.03 million	0.03 million	0.06 million	0.10 million
EoL motorcycles cumulative [number of devices]	0.30 million	0.35 million	0.45 million	0.69 million	1.13 million

2.2.8. Trucks

The number of trucks and lorries in 2011 (data available from 2005 until 2011 from CAPMAS statistical yearbook 2012) was around 1 million vehicles (16% of total vehicles). The 2005-2010 and 2006-2011 CAGR were 5.2%, respectively. Based on a 5.2% annual growth rate, around 2 million trucks and lorries are projeted to be in use in 2025 . (5.2% based on Mc Kinsey, 2010). This assumed growth rate is very much dependent on the economic growth. Figure 40 shows the projected number of trucks and lorries in use in Egypt.

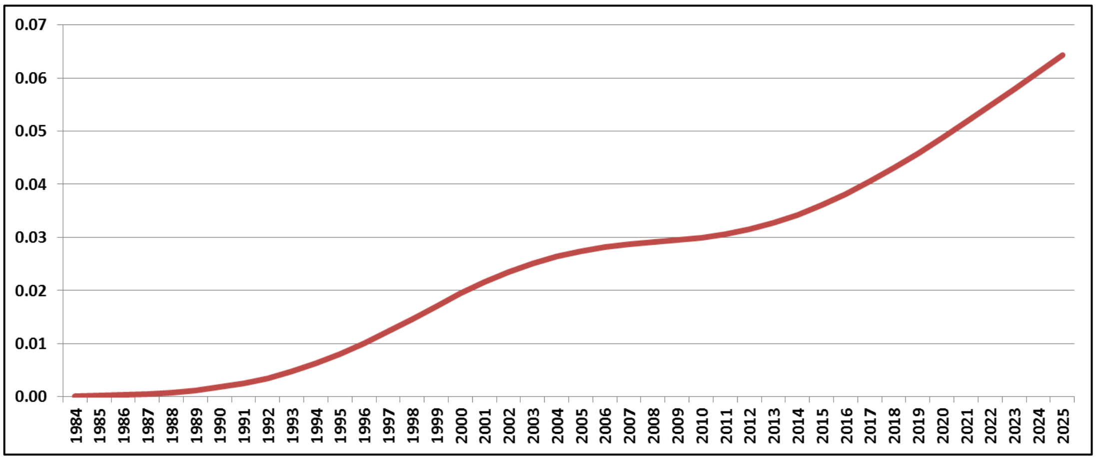
Figure 40 **Projection of the number of trucks and lorries in use in Egypt from 1984 to 2025 [in millions]**



Source: Projections by Oeko-Institut

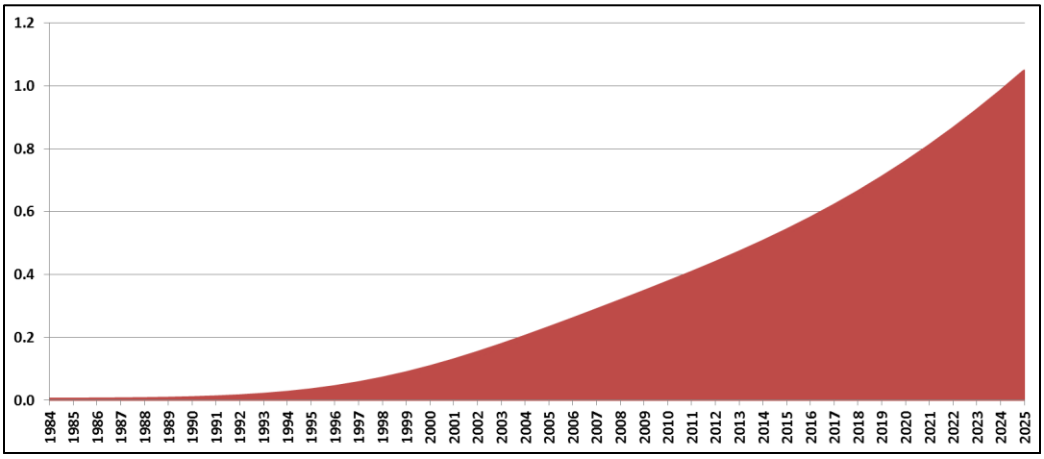
The average life time of one truck is assumed to be 20 years. Using the normal distribution (Gauss), the following number of EoL trucks and lorries are projected per year and in the cumulative view.

Figure 41 **Projection of the number of EoL trucks and lorries per year from 1984 to 2025 in Egypt [in millions]**



Source: Projections by Oeko-Institut

Figure 42 **Projection of the cumulative number of EoL trucks and lorries from 1984 to 2025 in Egypt [in millions]**



Source: Projections by Oeko-Institut

Table 13 shows 2010, 2012, 2015, 2020 and 2025 data for licensed trucks and lorries in use as well as for the number of end-of-life devices.

The assumptions made for the calculation and projection are given in the Annex.

Table 13 **Estimated and projected volumes of licensed trucks and lorries in use and at end-of-life in Egypt**

	2010	2012	2015	2020	2025
Licensed trucks and lorries in use [number of devices]	0.94 million	1.03 million	1.20 million	1.55 million	2.00 million
EoL trucks and lorries per year [number of devices]	0.03 million	0.03 million	0.04 million	0.05 million	0.06 million
EoL trucks and lorries cumulative [number of devices]	0.37 million	0.43 million	0.54 million	0.75 million	1.04 million

2.2.9. Other devices

The following products are relevant in terms of quantities on the market and consequently play a role in terms of quantities entering the waste stream. However, due to a lack of reliable data, the products listed below, in principle increasing the potential for recycling, have not been taken into further consideration in this study:

- Forklifts (lead acid batteries)
- DVD players (circuit boards, magnets)
- Hi-Fi units (circuit boards, magnets)
- Loudspeakers (magnets)
- Printers, faxes, copy machines (circuit boards)
- Radio sets (circuit boards, loudspeakers)
- Video recorders (circuit board)22
- Drilling machines (NiMH batteries)
- Pocket calculators (circuit boards)
- Servers, communication devices used in industry and business
- UPS (lead acid batteries)

Data on electronic and electric products from private and public sector production is shown in the table below. The data based on CAPMAS Statistical Report. This amount is a subset of the total number of put on the market as described in the chapters before.

[22] Egypt is a country with a significant film industry and history. A relatively high penetration of video has been assumed for the in the 1980sand 1990s with an estimation of around 20% of households equipped with a video player (assumption by Oeko-Institut). Video recorders were used until the end of the 1990s90th and then replaced by DVD recorders. Today, video players are no longer in uselittle is known on the whereabouts of these devices. It is assumed that the owners are still keeping them in their cellars etc.. Consequently, no relevant quantities of this waste category are shown in our projection.

Table 14 Data on Private Sector Production of E-Products in Egypt

No	Item by Unit	Year		
		2007	2008	2009
1	Electric Grills	33,224	31,569	36,550
2	Electric Water Boilers	59,025	3,552	20,127
3	Computers	95,288	78,589	63,708
4	Half Automatic Washing Machines	-	21,657	26,410
5	Electric Generators	1,102	1,238	1,359
6	Electric Transformers (High Power)	1,113	4,237	2,733
7	Electric Transformers (Small Power)	59,440	166,878	49,157
8	Colored TVs	1,268,548	951,375	858,840
9	Video Cassettes	10,150	4,115	-
10	Cassette Recorders	14,869	14,728	-
11	Satellite Receivers	4,313	-	-
12	Air Conditioners	543,123	745,862	782,194
13	Electric Commercial Fridges	16,017	34,442	35,338
14	Electrical Home Fridges	933,402	992,760	1,585,898
15	Deep Freezers	126,697	213,548	273,220
16	Dish Washing Machines	132,647	-	16,014
17	Full Automatic Washing Machines	386,009	501,616	4,285
18	Manual Washing Machines	215,903	35,539	562,24
19	Fans	2,754,221	3,055,710	2,135,100
20	Air Blowers	1,146,479	1,311,836	594,706
21	Vacuum Cleaners	304,503	287,711	101,192
22	Mixers	616,178	783,999	915,771
23	Egg Mixers	5,243	7,000	-
24	Hard Breakers	168,524	-	-
25	Hair Dryers	2,733	-	-
26	Irons	552,591	403,115	246,731
27	Electric Heaters for Drinks	1,800	286,900	10,500
28	Water Heaters	569,323	699,660	808,275
29	Air Heaters	659,718	898,935	27,644
30	Microwave Ovens	5,384	-	114

Source: CAPMAS Statistical Report

Table 15 Data on Public Sector Production of E-Products in Egypt

No	Item by Unit	Year			
		2006/2007	2007/2008	2008/2009	2009/2010
1	Air Conditioners	8,684	5,543	4,290	1,975
2	Full Automatic Washing Machines	87	4,566	452	-
3	Manual Washing Machines	-	199	-	-
4	Fans	11,445	10,091	11,144	1,759
5	Computers	10,246	12,036	9,083	4,513
6	Electric Motors with Small Power	62,329	11,393	9,128	20,666
7	Colored TVs	2,853	4,353	782	26,300
8	Radio Cassettes	3,169	3,862	15,924	5,350
9	Air Blowers	-	-	1,915	248
10	Electric Heaters	-	-	-	36,331

Source: CAPMAS Statistical Report

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3. Annex

Underlying data for the calculations regarding Egypt (population, households)

Calculations and projections are based on the respective population size and number of households.

- Data for the Egyptian population size has been based on CAPMAS Egypt statistical yearbook 2012. For the projection from 2013 until 2025, the “Medium” version of the scenario was chosen.
- The number of households was based on ITU 2012 data because this source provides a time series from 2002 until 2010. For 2000 and 2001, the size of households in 2002 (4.56 persons per households) has been used as a proxy. For the 2011 to 2025 projection, the 2010 household size (4.2 persons per household) has been used as a proxy accordingly.

Assumptions for mobile phones in Egypt

The following assumptions were made for the calculations and projections in this study:

- Life time of mobile phones (excluding battery): 10 years
- Life time of a mobile phone battery: 4 years
- The actual quantity of mobile phones in use in any given year was based on the number of mobile subscriptions, with a correction of 10% applied to this figure; assuming that 90% of mobile phone subscriptions are actively used.
- Normal distribution for the life time of mobile phones: μ= 10 years; σ= 3.3
- Normal distribution for the life time of mobile phone batteries: μ= 4 years; σ= 1.35
- The number of mobile phones in use in the years 2002 to 2004 was based on mobile subscriptions from ITU 2012 (due to a lack of data from other sources)
- Data for the years 2005-2013 was based on the number of mobile subscriptions per 100 inhabitants from MCIT, ICT indicators (2013)
- Projections for mobile phone subscriptions between 2014 and 2025 were based on the following assumptions (subscription growth 2014: 3% / 2015: 4% / 2016: 3.5% / 2017: 3.3% / 2018: 2.5%)
- By 2018, full market penetration of 1.20 active mobile phones per inhabitant will be reached (i.e., the growth rate for mobile subscriptions is assumed to reach 0% at this time).
- Average weight per mobile phone without battery and charger: 110 grams
- Average weight per mobile phone battery: 30 grams

- Gold content per average mobile phone: 0.024 grams
- Silver potential in one average mobile phone: 0.24 grams
- Palladium potential in one average mobile phone: 0.012 grams
- Copper potential in one average mobile phone: 8 grams
- Plastics potential in one average mobile phone: 20 grams
- Cobalt potential in one average mobile phone battery: 3.6 grams
- Different data source regarding mobile phone subscriptions are shown in Table 16

Table 16 Different data for mobile phones / subscriptions [compilation Oeko-Institut]

Source		2010	2011	2012	Comment
MCIT, ICT indicators 2013	Number of mobile subscribers per 100 inhabitants	90.4	102.8	116.9	
	Number of mobile subscriptions (calculated) [in mill.]	**70.4**	**81.8**	**95.2**	Calculated with number of population from CAPMAS
MCIT, ICT indicators 2013	Proportion of households with a mobile cellular phone	79.1%	92.5%	93.5%	
	mobile phones (minimum, probably more cells per hh)	**61.6**	**73.6**	**73.1**	Calculated with number of hh from ITU 2012
Egypt statistical yearbook. 2012, CAPMAS	Mobile Subscriptions [in Million subscribers]	**58.7**	**74.6**	**92.0**	Data for April of each year
ITU 2012	Mobile-cellular telephone subscriptions [in mill]	**70.7**	**84.4**		

Source: Compilation Oeko-Institut

Assumptions for computers in use and at EoL in Egypt

The following assumptions were made:

- Data based on MCIT ICT indicators 2013 "proportion of households using computers" (data available for years 2008 – 2012) (http://www.new.egyptictindicators.gov.eg/en/Indicators/_layouts/viewer.aspx?id=454)
- The number of households was based on ITU (2012) (see Assumptions for basic data above).
- The percentage of households with a computer will reach 60% in 2025 (Assumption Oeko-Institut)
  (Reason of lower rate than in Ghana: in rural areas, the market penetration will remain low in Egypt)
- It is assumed that the growth rate of households using a computer remains high (5%) until 2017 and flatters by 2025.
- Based on Hassanin (2003), in 2001, around 1 million computers were in use in Egypt. The calculation, of the number of computers in use was started with 1995 figures, where (0 million computers were in use). A linear increase was assumed for the years before 2001, based on the linear growth of hh with a computer from 2001 until 2008.
- The proportion of computers in offices per employee will increase to 4.5% by 2025 (Assumption by Oeko-Institut) assuming that the observed trend continues and the number of computers used in the service sector will further increase (in 2011: 3,5% computers in office per inhabitant)
- The share of notebooks in the total number of computers was 1% in 2001; 5% in 2005 and is predicted to reach 68% in 2025 (assumption by Oeko-Institut)
- A conservative 10-year life time has been assumed for computers (both desktops and notebooks) (assumption by Oeko-Institut). In Ghana, around 50% of computers in use are second hand. Since the second use phase is counted separately (i.e. as a new life time), the life time of a computer in Ghana is lower (4-7 years).
- Normal distribution for notebooks' and desktops' life times: μ= 10 years; σ= 3.3
- The average weights of computers in the period under review were assumed to be 8 kg (desktop computers) and 2.5 kg (notebooks) (Assumption by Oeko-Institut)
- Gold content per average desktop: 0.241 grams (source: Gmünder 2007)
- Silver potential in one average desktop: 1.398 grams (source: Gmünder 2007)
- Palladium potential in one average desktop: 0.099 grams (source: Gmünder 2007)
- Plastics potential in one average desktop: 722.781 grams (source: Gmünder 2007)
- Copper potential in one average desktop: 339.449 grams (source: Gmünder 2007)

- Gold content per average notebook: 0.094 grams (source: LANUV 2012)
- Silver potential in one average notebook: 0.416 grams (source: LANUV 2012)
- Palladium potential in one average notebook: 0.038 grams (source: LANUV 2012)
- Plastic potential in one average notebook: 705 grams
- The number of computers in use in offices in 2011 was based on data of the CAPMAS statistical yearbook 2012, Chapter Labour (for 2009 data, the statistical yearbook 2010 was used)
  - Table No 4-3 in the CAPMAS Egypt statistical yearbooks 2001 and 2009 (show estimates of employed persons by sex, industry & governorate
  - For each labor group, the following percentages of people using a computer were assumed for 2009 and 2011 (assumption by Oeko-Institut):
    - A[23], B[24], R[25], S[26], T[27]: 0%
    - C[28], D[29], E[30], F[31], I[32]: 5%
    - H[33], P[34], Q[35],: 10%
    - V[36], G[37]: 15%
    - L[38]: 20%
    - N[39], O[40]: 50%
    - J[41], K[42], M[43], U[44]: 80%

Assumptions for CRT and LCD monitors in Egypt

The following assumptions were made for the estimations / projection of CRT and LCD monitors in use and at EoL:

- The Number of monitors in use was based on the number of computers:
  - Each desktop is equipped with 1 monitor

23 Agriculture, Hunting, Forestry & Cutting of trees
24 Mining & Quarrying
25 Amusement & Creation & Arts Activities
26 Other Services Activities
27 Home Services for Private Households
28 Manufacturing
29 Electric, Gas, Steam, Air Condition Supply
30 Water Support, Drains, Recycling
31 Constructions
32 Food, Residence Services
33 Transportation & Storage
34 Education
35 Health and Social Work
36 Activities not classified
37 Whole and Retail Sale Vehicles, Motorcycles Repair
38 Real estate, Renting
39 Administrative Activities & Support Services
40 Public Administration, Defense, Social Solidarity
41 Information, Telecommunications
42 Insurance & Financial Intermediation
43 Specialized Technical, Scientific Activities
44 International and Regional Agencies & Organizations

- In 2013, 10% of notebooks were equipped with one additional monitor (2% in 2005, 22% in 2025) (average yearly growth 1%P) [in the projection for Ghana, 20% of notebooks are used with an additional monitor]

- Assumptions regarding the share of CRT monitors:
  - in 2002: 98% / 2005: 95% / 2012: 46% / 2025: 0% (from 2009 no more CRTs are put on the market, phase out of CRT´s in 2019);
- Life time CRT and LCD monitors is assumed to be 10 years (in Ghana the life time is assumed to be shorter due to the high import rate of second hand devices)
- Normal distribution for monitor life time: μ= 10 years; σ= 3.3
- The average weight of one CRT monitor is 14.230 kg (source: Wecycling 2009) and 4.7 kg for one LCD monitor (source: empa 2011)

Assumptions for CRT and LCD TVs in Egypt

The following assumptions were made for the projection of CRT and LCD TVs in use and at EoL in Egypt:

- The number of TVs in use is based on the proportion of households with a TV (MCIT 2013, Egypt ICT indicators (data available for years 2008-2012))
- The assumption regarding the percentages of households equipped with a TV for the years 2002-2007 were made by Oeko-Institut (90% of hh equipped with a TV in 2002, 96% in 2007)
- It is assumed by Oeko-Institut that full market saturation was reached when 97% of households were equipped with a TV, which has already been reached in 2012 (in the years 2012-2025 97%, of hh will be equipped with a TV)
- The share of households equipped with a TV is multiplied with the number of Egyptian households (source see above, basic data)
- An additional 10% for TVs in bars, restaurants, hotels, offices, second TVs in households is assumed for the whole period (assumption by Oeko-Institut)
- A share of 66% CRT TVs in 2012 and 34% by 2025 was assumed (by Oeko-Institut). It is assumed that the last CRT TV was put on the market in 2009.
- Life time of a CRT TV is assumed to be 20 years
- Normal distribution for CRT TV life time: μ= 20 years; σ= 6
- Life time for a LCD TV is assumed to be 10 years
- Normal distribution for LCD TV life time: μ= 10 years; σ= 3.3
- The average weight of an end-of-life CRT TV is 24.140 kg (source: Wecycling 2009) and of an end-of-life LCD 15 kg (source: Manhart et al. 2011)

Assumptions for keyboards and computer mice in Egypt

The following assumptions were used for the estimations / projection of keyboards and computer mice in use and at EoL in Egypt:

- A 10-year-life time is assumed for a keyboard as well as a computer mouse (assumption by Oeko-Institut)
- Normal distribution for keyboards and computer mice life times: μ= 10 years; σ= 3.3
- It is assumed that each desktop is equipped with a keyboard and computer mouse (assumption by Oeko-Institut).
- It is assumed that in 2013, around 10% of notebooks were equipped with a keyboard and a computer mouse (assumption by Oeko-Institut)
- The average weight of a keyboard is assumed to be 1 0006 grams (Eol list Bo2W project)
- The average weight of a computer mouse is assumed to be 111 grams (EoL list Bo2W project)

Assumptions for passenger vehicles in Egypt

The following assumptions were used for the estimations / projection of passenger vehicles in use and at EoL in Egypt:

- The life time of a passenger vehicle is assumed to be 20 years (assumption by Oeko-Institut)
- Normal distribution for passenger vehicle life time: μ= 20 years; σ= 6
- The number of passenger vehicles is based on CAPMAS statistical yearbook 2012 which contains data for 2005-2011 (see Table 17 below)
- It was assumed that passenger vehicles in the CAPMAS data comprise private cars and taxis
- For the projection, the growth rate CAGR 5.2% has been used (based on McKinsey, 2010)

Table 17 **Number of licensed vehicles by type of vehicle (end of December respectively) (2005-2011)**

Type of Vehicle	2011	2010	2009	2008	2007	2006	2005
Total	**6 322 433**	**5 714 385**	**5 137 495**	**4 656 636**	**4 239 866**	**3 953 811**	**3 662 888**
Private car	3 096 174	2 820 242	2 437 543	2 206 823	2 075 869	1 909 149	1 757 102
Caravan	1 056	815	1 127	1 113	1 015	998	909
Taxi	361 333	249 087	308 254	316 293	309 784	328 273	320 471
Bury's car	1 968	1 903	1 821	1 689	1 569	1 479	1 405
Bus	109 624	104 131	100 006	92 625	81 656	79 163	72 354
Public	19 134	18 638	16 981	16 598	16 153	16 097	15 043
Private	36 352	34 858	30 893	28 452	24 527	26 594	24 993
Tourism	16 756	16 210	15 932	15 101	12 343	11 125	10 128
Travels	26 435	23 995	27 701	25 405	22 314	19 503	16 976
Schools	10 947	10 430	8 499	7 069	6 314	5 844	5 214
Lorry	906 729	866 301	832 123	767 849	724 792	705 521	668 185
Truck	75 012	70 933	62 891	70 932	56 947	60 995	59 537
Tractor	19 252	19 485	21 408	23 064	22 872	23 643	23 229
Motor-cycle	1 525 556	1 374 775	1 166 481	995 781	793 107	645 893	578 978
Political Authority	6 365	5 879	5 026	4 026	4 034	3 878	3 687
Comm.& Temporary	12 349	12 197	21 316	19 265	12 229	13 150	12 954
Custom Plate	67 368	50 905	45 935	28 942	25 126	47 846	31 116
Public Sector	32 067	31 286	28 211	31 356	33 491	43 681	43 593
Government	64 620	64 063	63 424	58 343	58 548	55 218	55 013
Governorate	42 960	42 383	41 929	38 535	38 827	34 924	34 355

Source: CAPMAS Egypt statistical yearbook 2012

Assumptions for motorcycles in Egypt

The following assumptions were used for the estimations / projection of motorcycles in use and at EoL in Egypt:

- The life time of a motorcycle is assumed to be 20 years (assumption by Oeko-Institut)
- Normal distribution for motorcycles life time: μ= 20 years; σ= 6
- The number of motorcycles was based on CAPMAS statistical yearbook 2012 which contains data for 2005-2011 (see Table 17 above)
- For the projection, the growth rate of CAGR 5.2% has been used, based on (McKinsey 2010)

Assumptions for trucks in Egypt

The following assumptions were used for the estimations / projection of trucks in use and at EoL in Egypt:

- The life time of a truck / lorry is assumed to be 20 years (assumption by Oeko-Institut)
- Normal distribution for trucks' life time: μ= 20 years; σ= 6
- The number of trucks and lorries has been based on t CAPMAS statistical yearbook 2012 which contains data for 2005-2011 (see Table 17 above)

- For the projection, the growth rate of CAGR 5.2% has been used, based on McKinsey, 2010)