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UNU-VIE SCYCLE

Sustainable Cycles Programme

SCYCLE

Programme

E-waste statistics

General principles of e-waste statistics

Training on e-waste statistics

9 June 2021, Arab Region

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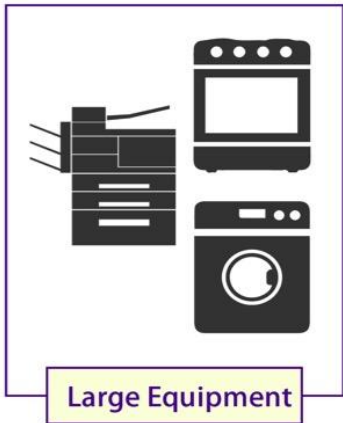
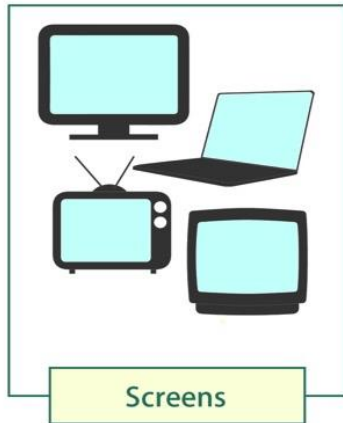
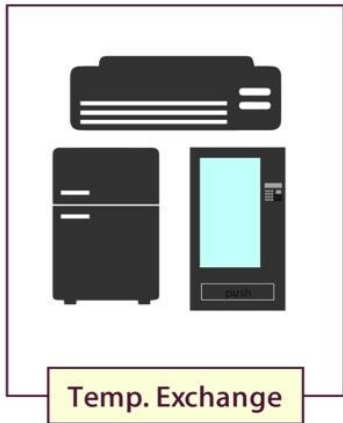
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Outline

- Harmonized framework to measure e-waste
- E-waste classification
- Measure e-waste
- Minimum requirements for e-waste statistics

What is e-waste



EEE: Electrical and electronic equipment (EEE) includes a wide range of products almost any household or business are with circuitry, or electrical components with power or battery supply (Step Initiative 2014).

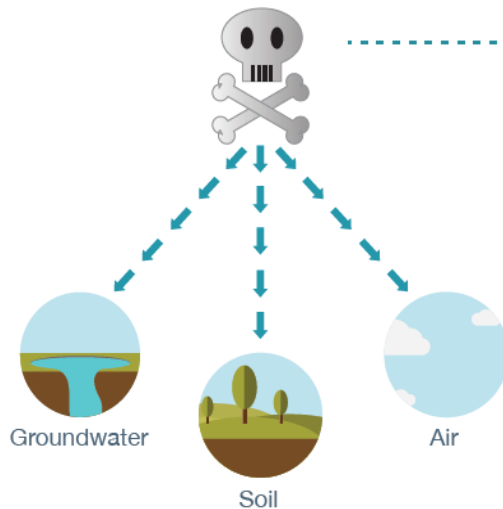
E-waste: refers to all items of electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of re-use

E-waste global problems

1. Hazardous materials in e-waste

e.g. fridges, phones, laptops, washing machines, sensors, TVs, lamps

- Heavy metals (such as mercury, lead, cadmium etc.)
- Chemicals (such as CFCs/chlorofluorocarbon or various flame retardants)



E-waste can pose considerable environmental and health risks.



E-waste global problems

2. Impact on health

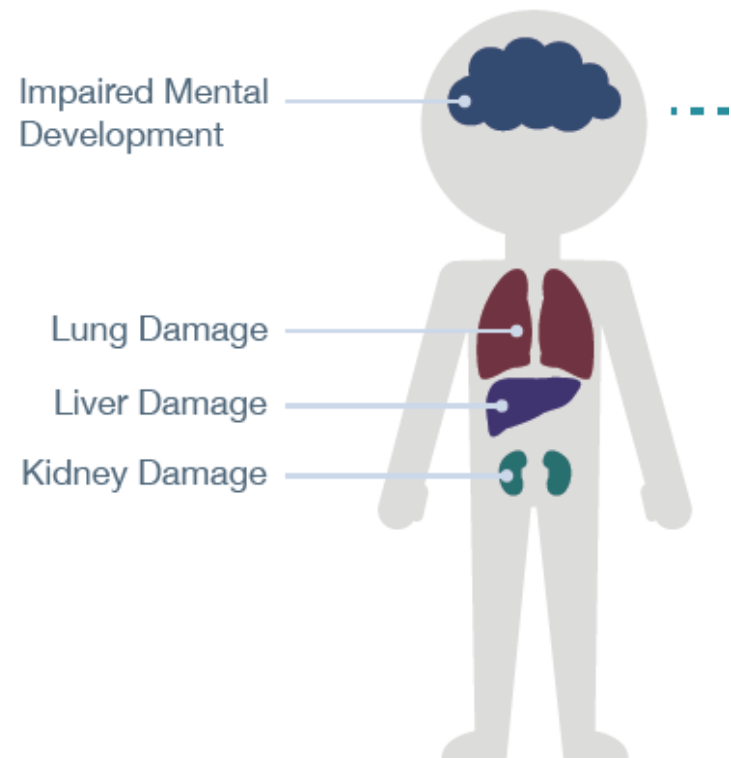
- Exposure to lead
 - Mental development of children, toxic to kidneys

- When burning PVC → dioxins
 - One of the most hazardous carcinogens (cancer)

- Hexavalent Chromium
 - Kidney, liver, DNA

- Brominated Flame retardants
 - Fetal damage

- Cadmium
 - Cancer, toxic to kidneys



E-waste opportunities:

Legend:

- nonmetal (orange)
- metal (blue)
- transition metal (light blue)
- metalloid (green)

Red boxes highlight the following elements:

- Li, Be
- Al, Si
- V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr
- Rb, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe
- Cs, Ba, La, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Po, At, Rn
- Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu

- At least 57 elements:

- Materials
- Base metals
- Precious metals
- Rare earth metals
- Plastics
- Glass
-

- Hazardous materials

- Mercury
- CFCs
- Lead
- Flame retardants
-

Harmonized framework to measure e-waste:

Background

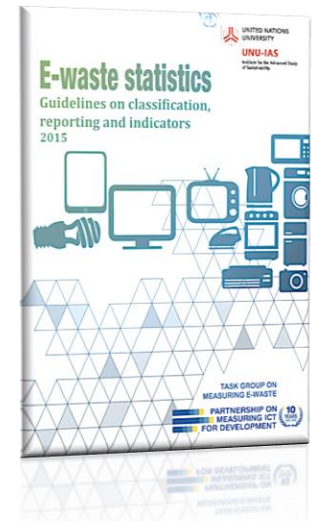
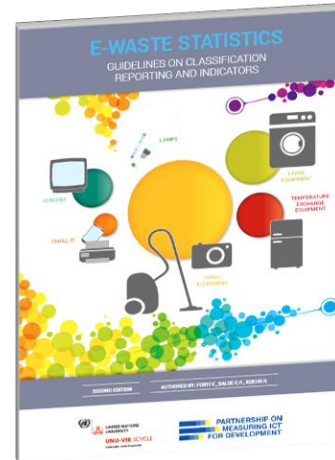
- Fast growing problem
- Little data. There is too much discrepancy between official/governmental data and academic data.
- Link to existing statistics and e-waste related data
- Needed to capture e-waste most essential features
- Objectives:
 - Develop a framework and internationally defined indicators:

 PARTNERSHIP ON
MEASURING ICT
FOR DEVELOPMENT

Harmonized framework to measure e-waste:

The Partnership Measuring ICT for Development

- Objective
- Support the compilation of reliable data on e-waste as a basis for political decision making and the environmentally sound management of used and end of life electric and electronic equipment.
- Output
 - Published guidelines (in 2015 and 2018)
 - Publicly consulted
 - http://collections.unu.edu/eserv/UNU:6477/RZ_EWaste_Guidelines_LoRes.pdf
 - Questionnaires with OECD and UNSD on e-waste following the principles of the framework.



How to classify e-waste

- Six E-waste Categories
- UNU-KEYS
- Basel convention codes
- EU List of Waste Codes

Hazardous	
09 01 11*	Single-use cameras containing batteries included in 16 06 01, 16 06 02 or 16 06 03
16 02 09*	Transformers and capacitors containing PCBs
16 02 10*	Discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09
16 02 11*	Discarded equipment containing chlorofluorocarbons, HCFC, HFC
16 02 12*	Discarded equipment containing free asbestos
16 02 13*	Discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12
20 01 21*	Fluorescent tubes and other mercury-containing waste
20 01 23*	Discarded equipment containing chlorofluorocarbons
20 01 35*	Discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components
Non-hazardous	
09 01 10	Single-use cameras without batteries
09 01 12	Single-use cameras containing batteries other than those mentioned in 09 01 11
16 02 14	Discarded equipment other than those mentioned in 16 02 09 to 16 02 13
20 01 36	Discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23, and 20 01 35

- E-waste should be presumed to be hazardous waste, unless it can be shown that it does not contain such components,
- in text it sums up the hazardous components
- For instance
 - Lead-containing glass from cathode ray tubes (CRTs) and imaging lenses, which are assigned to Annex VIII entries A1180 or A2010, “Glass from cathode ray tubes and other activated glass.” This waste also belongs to category Y31 in Annex I, “Lead; lead compounds” and is likely to possess hazardous characteristics H6.1, H11, H12, and H13 included in Annex III;
 - Nickel-cadmium batteries and batteries containing mercury, which are assigned to Annex VIII entry A1170, “Unsorted waste batteries...” This waste also belongs to category Y26 in Annex I, “Cadmium; cadmium compounds” or Y29, “Mercury, mercury compounds” and is likely to possess hazardous characteristics H6.1, H11, H12, and H13;
 - Etc..

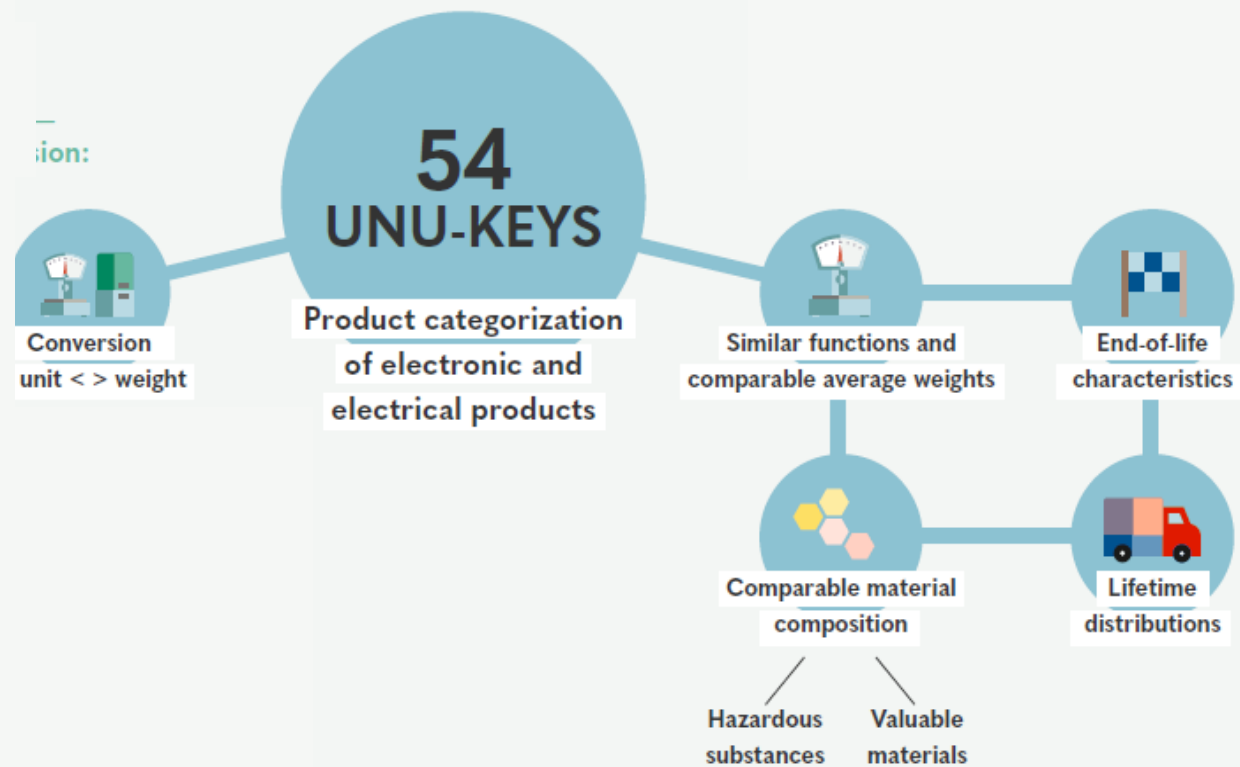
■ A1180

- Waste electrical and electronic assemblies or scrap containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB capacitors, or contaminated with Annex I constituents (e.g. cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III (note the related entry on list B, B1110)."

■ B1110 Electrical and electronic assemblies:

- Electronic assemblies consisting only of metals or alloys;
- Waste electrical and electronic assemblies or scrap (including printed circuit boards) not containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or not contaminated with Annex I constituents (e.g., cadmium, mercury, lead, polychlorinated biphenyl) or from which these have been removed, to an extent that they do not possess any of the characteristics contained in Annex III (note the related entry on list A A1180);
- Electrical and electronic assemblies (including printed circuit boards, electronic components and wires) destined for direct reuse, and not for recycling or final disposal."
- This entry does not include scrap from electrical power generation.
- Reuse can include repair, refurbishment or upgrading, but not major reassembly.
- In some countries these materials destined for direct reuse are not considered wastes.

Requirements for good classification for measuring e-waste

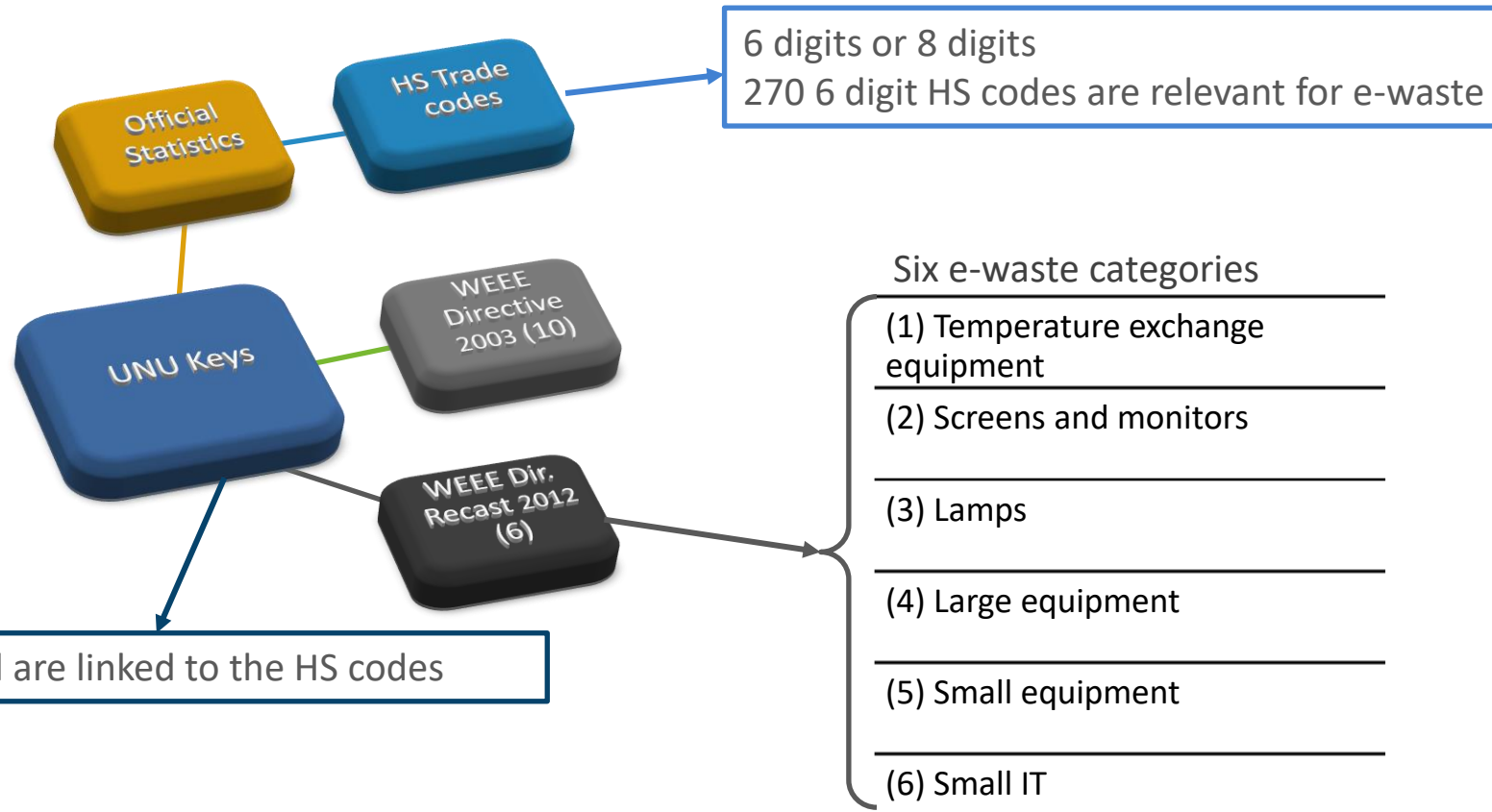


Few examples of UNU-KEYS

UNU KEY	Description	EEE category under EU-6
0001	Central Heating (household installed)	Large equipment
0002	Photovoltaic Panels (incl. inverters)	Large equipment
0101	Professional Heating & Ventilation (excl. cooling equipment)	Large equipment
0102	Dishwashers	Large equipment
0103	Kitchen equipment (e.g. large furnaces, ovens, cooking equipment)	Large equipment
0104	Washing Machines (incl. combined dryers)	Large equipment
0105	Dryers (wash dryers, centrifuges)	Large equipment
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	Large equipment
0108	Fridges (incl. combi-fridges)	Temperature exchange equipment

E-waste classification:

UNU-KEYS Product classification

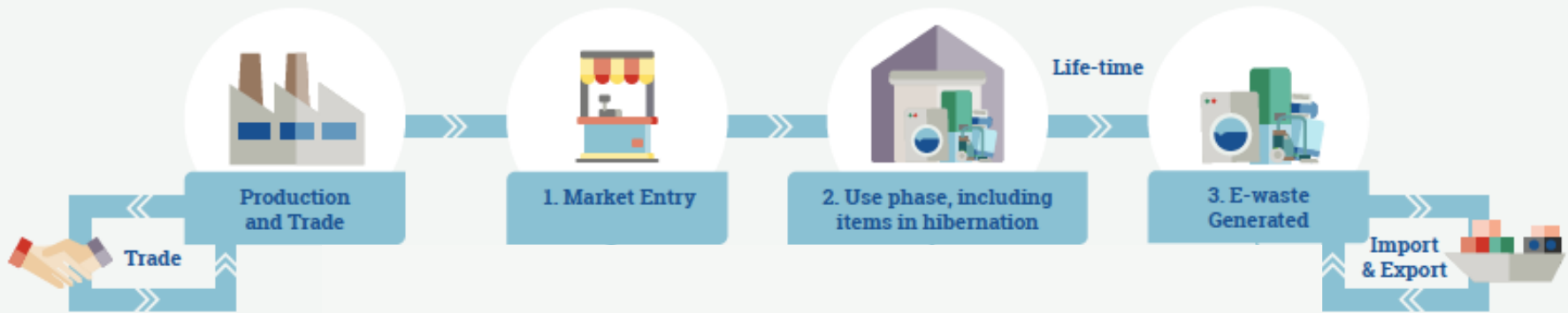


E-waste classification:

Link UNU-KEYS to the HS codes

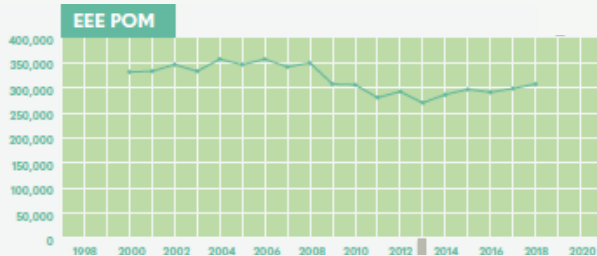
UNU-KEY	UNU KEY DESCRIPTION	HS	HS DESCRIPTION
0001	Central Heating (household installed)	840310	Boilers; central heating boilers (excluding those of heading no. 8402)
0001	Central Heating (household installed)	854140	Electrical apparatus; photosensitive, including photovoltaic cells, whether or not assembled in modules or made up into panels, light emitting diodes
0101	Professional Heating & Ventilation (excl. cooling equipment)	845110	Dry-cleaning machines
0101	Professional Heating & Ventilation (excl. cooling equipment)	845130	Ironing machines and presses (including fusing presses)
0102	Dish washers	842211	Dish washing machines; of the household type
0102	Dish washers	842219	Dish washing machines; of other than household type
0103	Kitchen equipment (e.g. large furnaces, ovens, cooking equipment)	851660	Ovens, cookers, cooking plates, boiling rings, grillers and roasters; of a kind used for domestic purposes (excluding microwaves)
0104	Washing Machines (incl. combined dryers)	845011	Washing machines; household or laundry-type, fully-automatic, (of a dry linen capacity not exceeding 10kg)
0104	Washing Machines (incl. combined dryers)	845012	Washing machines; household or laundry-type, with built-in centrifugal drier, (not fully-automatic), of a dry linen capacity not exceeding 10kg
0104	Washing Machines (incl. combined dryers)	845019	Washing machines; household or laundry-type, not fully-automatic, without built-in centrifugal drier, of a dry linen capacity not exceeding 10kg
0104	Washing Machines (incl. combined dryers)	845020	Washing machines; household or laundry-type, of a dry linen capacity exceeding 10kg
0105	Dryers (wash dryers, centrifuges)	842112	Centrifuges; clothes-dryers
0105	Dryers (wash dryers, centrifuges)	845121	Drying machines; of a dry linen capacity not exceeding 10kg
0105	Dryers (wash dryers, centrifuges)	845129	Drying machines; of a dry linen capacity exceeding 10kg
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	841460	Hoods; ventilating or recycling hoods incorporating a fan, whether or not fitted with filters, having a maximum horizontal side not exceeding 120cm
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	851621	Heating apparatus; electric storage heating radiators
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	851629	Heating apparatus; electric soil heating apparatus and space heating apparatus (excluding storage heating radiators)
0108	Fridges (incl. combi-fridges)	841810	Refrigerators and freezers; combined refrigerator-freezers, fitted with separate external doors, electric or other
0108	Fridges (incl. combi-fridges)	841821	Refrigerators; for household use, compression-type, electric or other

Measure the entire lifecycle



Need data – consumption (Placed on Market)

- Trade statistics and domestic production statistics
- Apparent consumption methodology
- $\text{EEE Placed on Market} = \text{Domestic Production} + \text{Imports} - \text{Exports}$



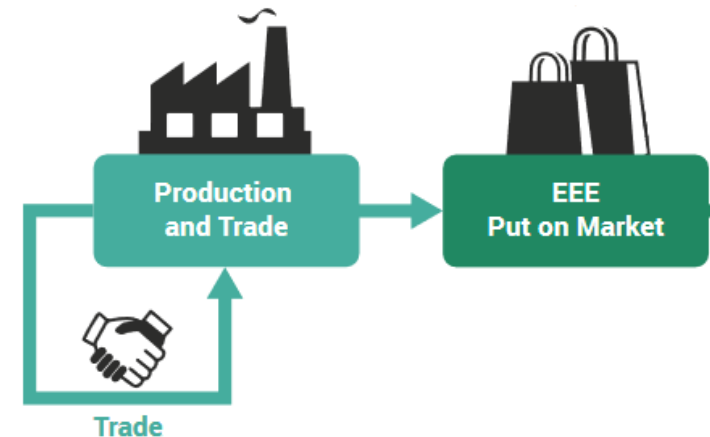
Track EEE Put on Market

■ Requirements

- Long time series (30 years)
- For 54 UNU-KEYS

■ Data sources

- Data collected and published by specific registers or custom organizations and/or national statistical institutes
- “Apparent consumption method”
- Link between trade statistics and national production statistics

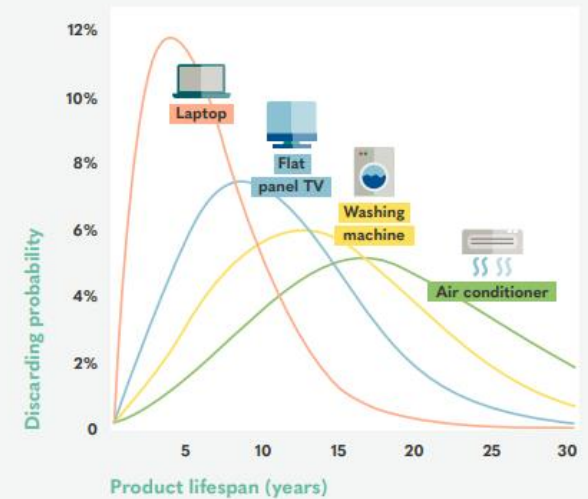
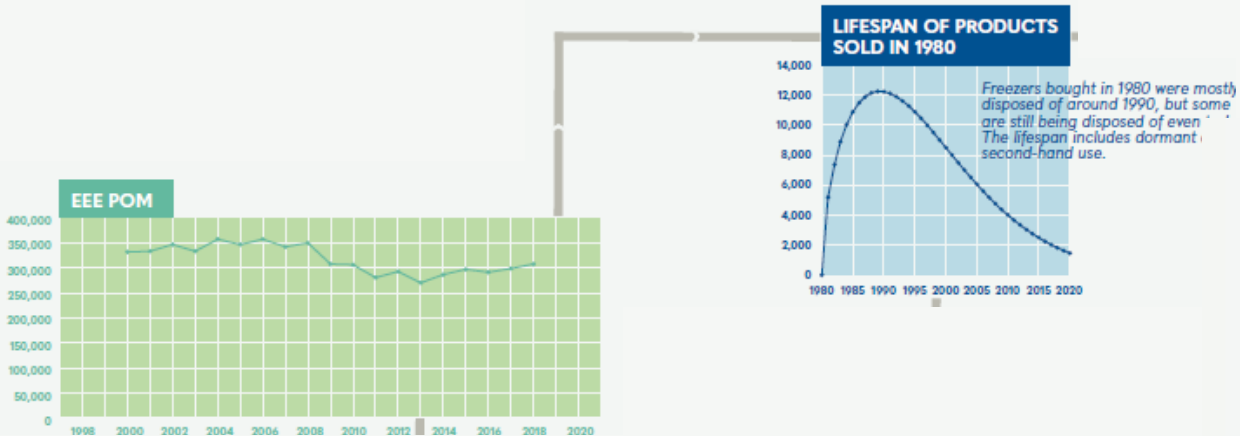


$$POM(t) = Domestic\ production(t) + Imports(t) - Exports(t)$$

Lifespans

- Household and business surveys
- Weibull function

$$L^{(p)}(t, n) = \frac{\alpha(t)}{\beta(t)^{\alpha(t)}} (n-t)^{\alpha(t)-1} e^{-[(n-t)/\beta(t)]^{\alpha(t)}}$$



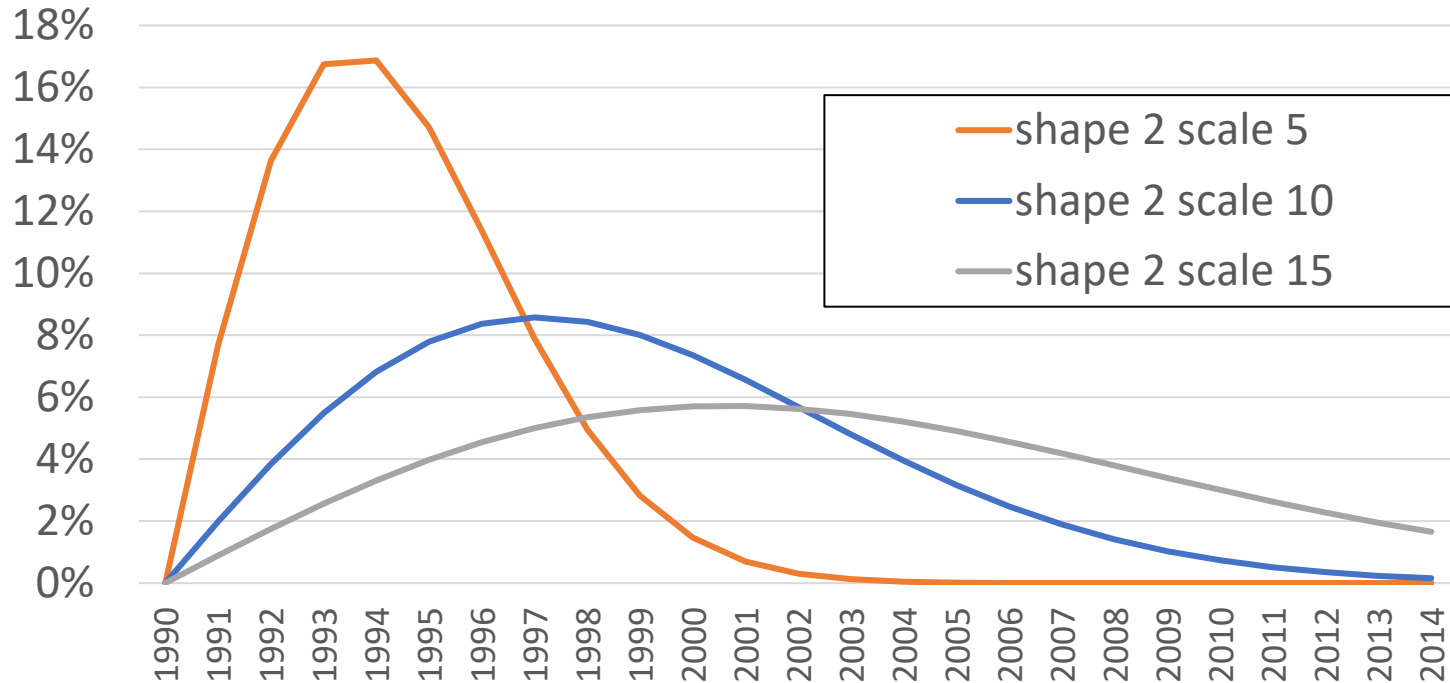
EEE life-time

(Time spent at household, business or public sector)

- Includes the exchange of second-hand equipment
- Should ideally be determined empirically per product
- Possible data available from studies
- UNU calculates the lifespan using Weibull functions (Wang et al., 2013)
- Data can be measured with:
 - Household surveys
 - Waste collection points
 - Work with universities / Literature



Weibull function



$$L^{(p)}(t, n) = \frac{\alpha}{\beta^\alpha} (n - t)^{\alpha-1} e^{-[(n-t)/\beta]^\alpha}$$

Alpha = shape

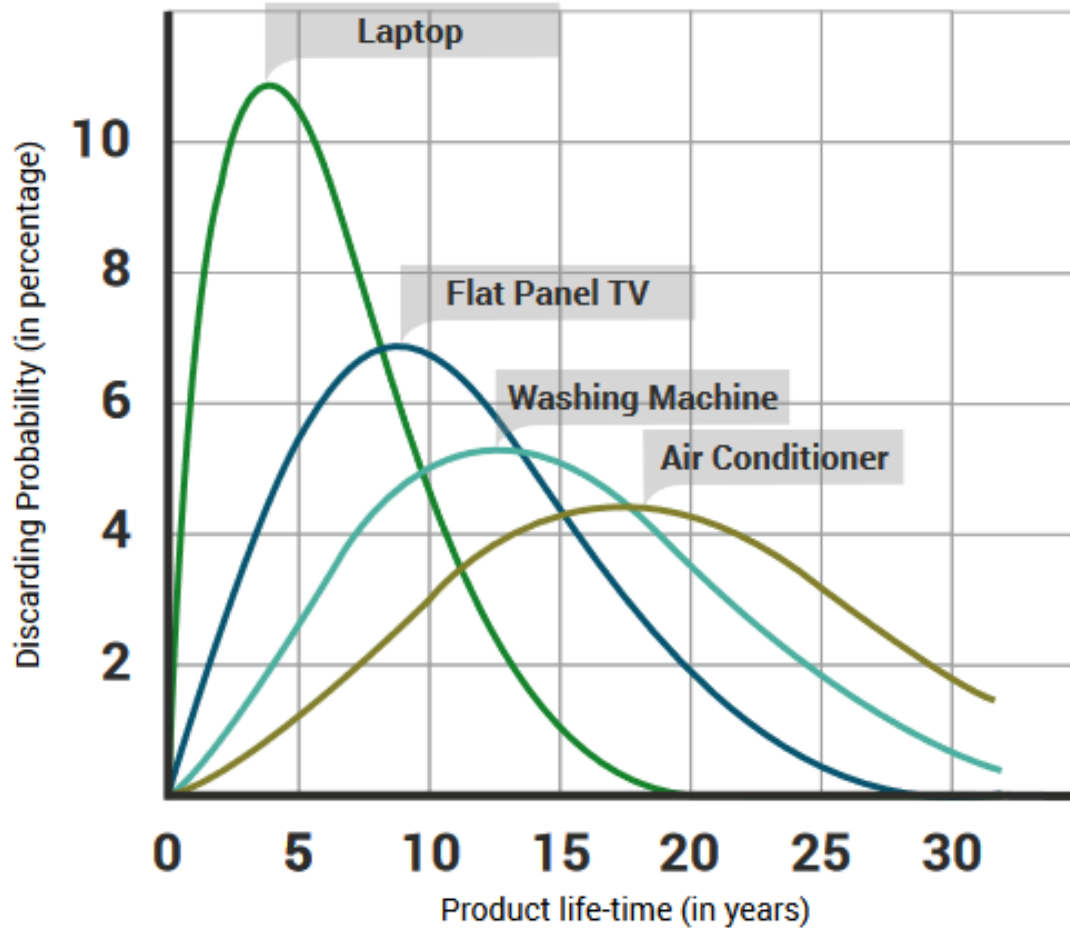
Beta = scale

t= time

n = reference year

L = lifespan

EEE life-time: examples



EEE life-time:

Parameters

- Shape and scale parameters can be found in the guidelines
- Parameters were obtained for Belgium, Italy, the Netherlands and France

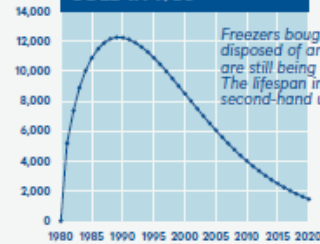
UNU-KEYS * Data refers to 2016	WEIBULL LIFE-TIME DISTRIBUTION IN THE NETHERLANDS, FRANCE AND BELGIUM		WEIBULL LIFE-TIME DISTRIBUTION IN ITALY		PROXY OF WEIBULL LIFE-TIME DISTRIBUTION USED FOR NON EU COUNTRIES	
	α	β	α	β	α	β
0001	2.00	14.21	2.00	14.21	2.00	14.21
0002	3.50	25.00	3.50	25.00	NA	NA
0101	1.95	17.52	1.14	16.07	1.92	16.07
0102	1.64	14.20	1.37	14.28	1.79	17.13
0103	2.47	18.04	1.31	19.35	2.00	19.35
0104	2.20	15.16	2.20	13.65	1.85	13.32
0105	2.58	15.73	2.58	15.73	2.58	18.08
0106	2.00	13.47	1.22	18.80	2.00	13.47
0108	2.20	16.43	2.36	18.50	2.20	16.71
0109	2.74	24.20	1.28	18.55	1.28	18.55
0111	2.69	14.52	1.05	7.53	2.00	20.60
0112	2.39	13.56	1.29	8.29	2.36	13.36
0113	2.44	20.56	2.50	18.02	1.60	15.36
0114	1.90	14.07	1.33	9.05	2.07	17.99
0201	1.25	8.17	0.83	6.53	1.22	7.97
0202	2.06	11.22	1.15	9.57	2.02	11.02
0203	1.73	7.80	1.18	7.61	1.18	7.61
0204	1.45	10.25	1.22	10.59	1.22	10.59
0205	1.26	10.67	1.20	8.09	1.20	8.09
0301	1.25	5.91	1.30	6.15	1.30	6.15
0302	1.58	8.95	1.57	8.91	1.80	10.33
0303	1.60	6.57	1.66	6.81	1.94	8.76
0304	1.68	9.91	1.53	6.88	1.88	9.31
0305	1.24	7.22	1.32	7.70	1.32	7.70

E-waste generation

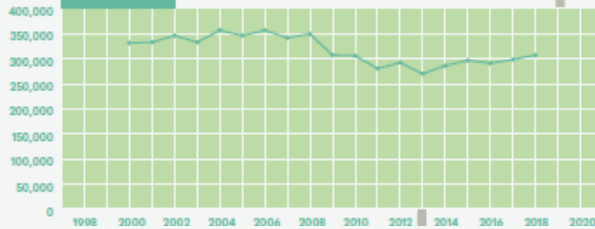
[1]

$$\text{WEEE Generated (n)} = \sum_{t=t_0}^n \text{POM}(t) * L^{(p)}(t, n)$$

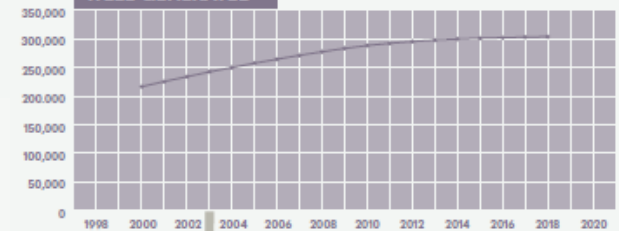
LIFESPAN OF PRODUCTS SOLD IN 1980



EEE POM



WEEE GENERATED



Measure e-waste generated

EEE is disposed of after a certain lifetime and becomes e-waste (generated)

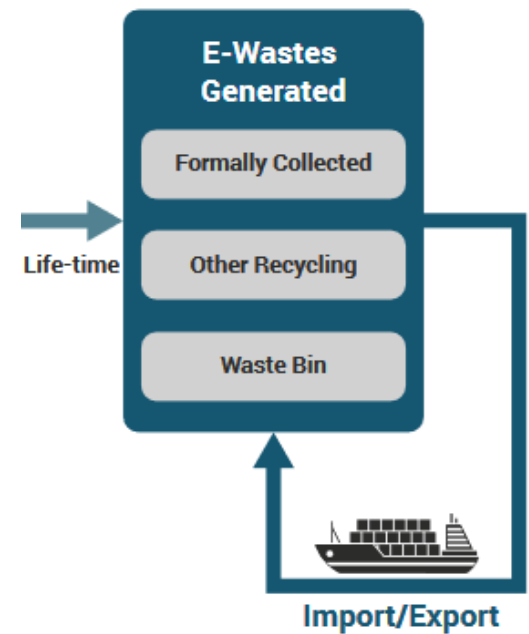
■ E-waste generated

- E-waste amounts prior to collection/treatment
- excludes imports of e-waste.

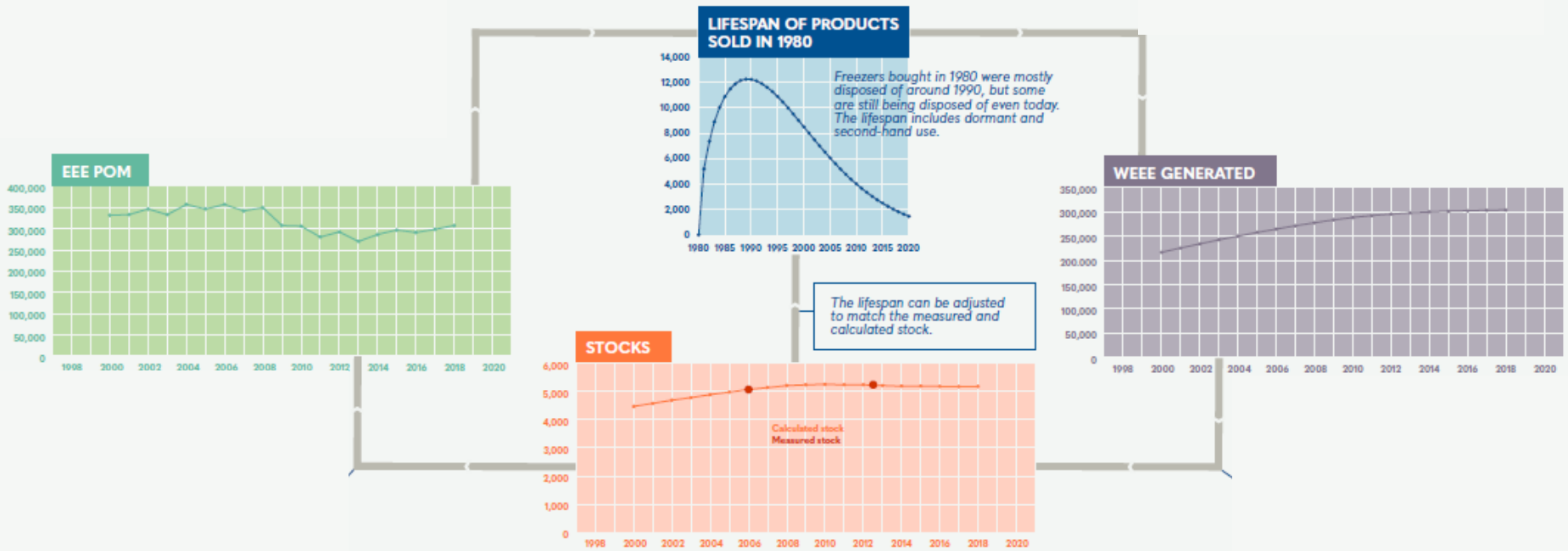
■ E-waste generated in a given year in a specific country is based on:

- Amount of EEE placed on the market (POM) in the preceding years
- Corresponding product lifespan

$$E \text{ waste generated } (n) = \sum_{t=t_0}^n POM(t) * L^{(p)}(t, n)$$



POM-Stock-Flow modelling



International defined indicators

- EEE Placed on Market (kg/inh)
- E-waste Generated (kg/inh)
- E-waste recycled (kg/inh)
- E-waste recycling rate (%)

SDG 12.5.1 National recycling rate and tons of material recycled (e-waste sub-indicator)

The e-waste sub-indicator in SDG 12.5.1 has been defined as:

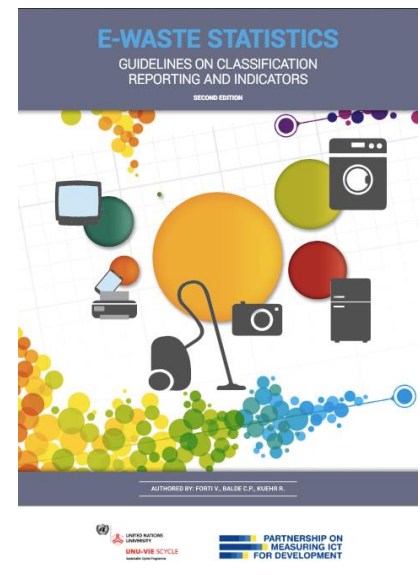
$$\text{SDG 12.5.1 Sub-indicator on e-waste} = \frac{\text{Total e-waste recycled}}{\text{Total e-waste generated}}$$

Measure e-waste:

UNSD questionnaire as part of waste statistics

- Questionnaire (UNSD/UN Environment Questionnaire on Environment Statistics – waste section [which includes the two variables on e-waste])
https://unstats.un.org/unsd/envstats/Questionnaires/2018/q2018Waste_English.pdf
- Total E-waste generated
- Total E-waste formally collected
- Insert national definitions of e-waste

- Excel File Electronic Products entering Market 1980-now + Manual
 - Uses Trade Statistics (HS codes) and domestic production statistics
- Excel File E-waste Generated + manual
 - lifespans and Products entering market
- Ready to use:
 - Tailor made / pre-filled per country
- Statistical guidelines
 - available in RU/EN/ES
- Capacity building page at www.globalewaste.org



Arab States Project

- Implemented by United Nations University and ITU
- Close cooperation with UNEP and UN ESCWA

Goals

- Map statistics and e-waste policies
- Build capacity on e-waste statistics

How

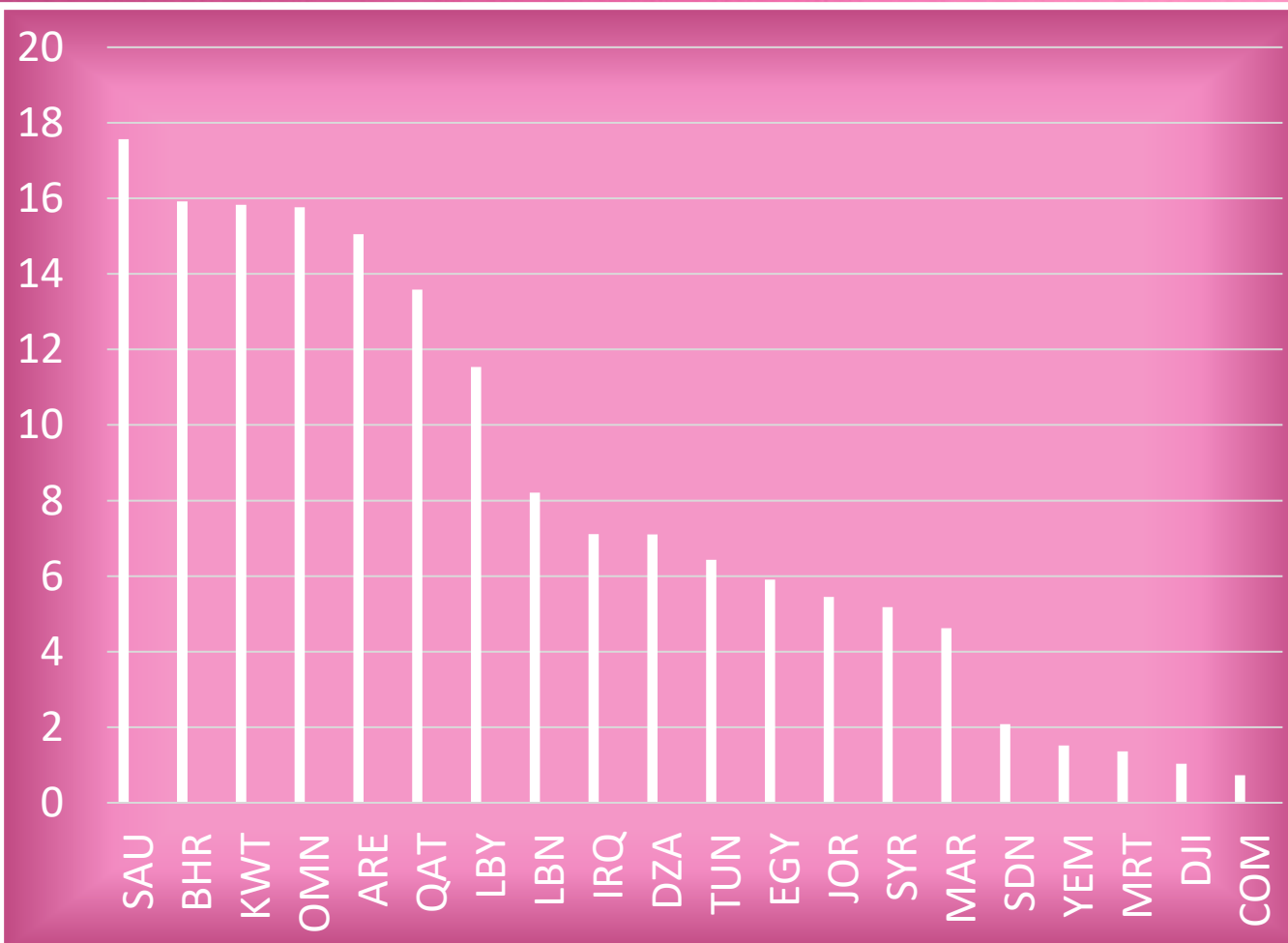
- Statistical Tools
- Workshop Tunis December 2019
- Questionnaire

Regional e-waste monitor

- To be published December 2021



E-waste Generation Arab Region (kg/inhabitant)



2.8 Mt in 2020



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