E-waste statistics

General principles of e-waste statistics

Training on e-waste statistics
9 June 2021, Arab Region
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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 circuity, 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.*
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:

- 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:
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
  - 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
<table>
<thead>
<tr>
<th>Hazardous</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>09 01 11</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Single-use cameras containing batteries included in 16 06 01, 16 06 02 or 16 06 03</td>
</tr>
<tr>
<td><strong>16 02 09</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Transformers and capacitors containing PCBs</td>
</tr>
<tr>
<td><strong>16 02 10</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09</td>
</tr>
<tr>
<td><strong>16 02 11</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Discarded equipment containing chlorofluorocarbons, HCFC, HFC</td>
</tr>
<tr>
<td><strong>16 02 12</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Discarded equipment containing free asbestos</td>
</tr>
<tr>
<td><strong>16 02 13</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12</td>
</tr>
<tr>
<td><strong>20 01 21</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Fluorescent tubes and other mercury-containing waste</td>
</tr>
<tr>
<td><strong>20 01 23</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Discarded equipment containing chlorofluorocarbons</td>
</tr>
<tr>
<td><strong>20 01 35</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>Discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-hazardous</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>09 01 10</strong></td>
<td>Single-use cameras without batteries</td>
</tr>
<tr>
<td><strong>09 01 12</strong></td>
<td>Single-use cameras containing batteries other than those mentioned in 09 01 11</td>
</tr>
<tr>
<td><strong>16 02 14</strong></td>
<td>Discarded equipment other than those mentioned in 16 02 09 to 16 02 13</td>
</tr>
<tr>
<td><strong>20 01 36</strong></td>
<td>Discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23, and 20 01 35</td>
</tr>
</tbody>
</table>
E-waste in Basel Convention

- 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..
Basel Convention Codes

- 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

54 UNU-KEYS

- Conversion unit <-> weight
- Product categorization of electronic and electrical products
- Similar functions and comparable average weights
- End-of-life characteristics
- Comparable material composition
  - Hazardous substances
  - Valuable materials
- Lifetime distributions
<table>
<thead>
<tr>
<th>UNU KEY</th>
<th>Description</th>
<th>EEE category under EU-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0001</td>
<td>Central Heating (household installed)</td>
<td>Large equipment</td>
</tr>
<tr>
<td>0002</td>
<td>Photovoltaic Panels (incl. inverters)</td>
<td>Large equipment</td>
</tr>
<tr>
<td>0101</td>
<td>Professional Heating &amp; Ventilation (excl. cooling equipment)</td>
<td>Large equipment</td>
</tr>
<tr>
<td>0102</td>
<td>Dishwashers</td>
<td>Large equipment</td>
</tr>
<tr>
<td>0103</td>
<td>Kitchen equipment (e.g. large furnaces, ovens, cooking equipment)</td>
<td>Large equipment</td>
</tr>
<tr>
<td>0104</td>
<td>Washing Machines (incl. combined dryers)</td>
<td>Large equipment</td>
</tr>
<tr>
<td>0105</td>
<td>Dryers (wash dryers, centrifuges)</td>
<td>Large equipment</td>
</tr>
<tr>
<td>0106</td>
<td>Household Heating &amp; Ventilation (e.g. hoods, ventilators, space heaters)</td>
<td>Large equipment</td>
</tr>
<tr>
<td>0108</td>
<td>Fridges (incl. combi-fridges)</td>
<td>Temperature exchange equipment</td>
</tr>
</tbody>
</table>
E-waste classification:

**UNU-KEYS Product classification**

- Temperature exchange equipment
- Screens and monitors
- Lamps
- Large equipment
- Small equipment
- Small IT

54 codes and are linked to the HS codes

6 digits or 8 digits

270 6 digit HS codes are relevant for e-waste
E-waste classification:

*Link UNU-KEYS to the HS codes*

<table>
<thead>
<tr>
<th>UNU-KEY</th>
<th>UNU KEY DESCRIPTION</th>
<th>HS</th>
<th>HS DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0001</td>
<td>Central Heating (household installed)</td>
<td>840310</td>
<td>Boilers; central heating boilers (excluding those of heading no. 8402)</td>
</tr>
<tr>
<td>0001</td>
<td>Central Heating (household installed)</td>
<td>854140</td>
<td>Electrical apparatus; photosensitive, including photovoltaic cells, whether or not assembled in modules or made up into panels, light emitting diodes</td>
</tr>
<tr>
<td>0101</td>
<td>Professional Heating &amp; Ventilation (excl. cooling equipment)</td>
<td>845110</td>
<td>Dry-cleaning machines</td>
</tr>
<tr>
<td>0101</td>
<td>Professional Heating &amp; Ventilation (excl. cooling equipment)</td>
<td>845130</td>
<td>Ironing machines and presses (including fusing presses)</td>
</tr>
<tr>
<td>0102</td>
<td>Dish washers</td>
<td>842211</td>
<td>Dish washing machines; of the household type</td>
</tr>
<tr>
<td>0102</td>
<td>Dish washers</td>
<td>842219</td>
<td>Dish washing machines; of other than household type</td>
</tr>
<tr>
<td>0103</td>
<td>Kitchen equipment</td>
<td>851660</td>
<td>Ovens, cookers, cooking plates, boiling rings, grills and roasters; of a kind used for domestic purposes (excluding microwaves)</td>
</tr>
<tr>
<td>0104</td>
<td>Washing Machines (incl. combined dryers)</td>
<td>845011</td>
<td>Washing machines; household or laundry-type, fully-automatic, (of a dry linen capacity not exceeding 10kg)</td>
</tr>
<tr>
<td>0104</td>
<td>Washing Machines (incl. combined dryers)</td>
<td>845012</td>
<td>Washing machines; household or laundry-type, with built-in centrifugal drier, (not fully-automatic), of a dry linen capacity not exceeding 10kg</td>
</tr>
<tr>
<td>0104</td>
<td>Washing Machines (incl. combined dryers)</td>
<td>845019</td>
<td>Washing machines; household or laundry-type, not fully-automatic, without built-in centrifugal drier, of a dry linen capacity not exceeding 10kg</td>
</tr>
<tr>
<td>0104</td>
<td>Washing Machines (incl. combined dryers)</td>
<td>845020</td>
<td>Washing machines; household or laundry-type, of a dry linen capacity exceeding 10kg</td>
</tr>
<tr>
<td>0105</td>
<td>Dryers (wash dryers, centrifuges)</td>
<td>842112</td>
<td>Centrifuges; clothes dryers</td>
</tr>
<tr>
<td>0105</td>
<td>Dryers (wash dryers, centrifuges)</td>
<td>845121</td>
<td>Drying machines; of a dry linen capacity not exceeding 10kg</td>
</tr>
<tr>
<td>0105</td>
<td>Dryers (wash dryers, centrifuges)</td>
<td>845129</td>
<td>Drying machines; of a dry linen capacity exceeding 10kg</td>
</tr>
<tr>
<td>0106</td>
<td>Household Heating &amp; Ventilation (e.g. hoods, ventilators, space heaters)</td>
<td>841160</td>
<td>Hood; ventilating or recycling hoods incorporating a fan, whether or not fitted with filters, having a maximum horizontal side not exceeding 120cm</td>
</tr>
<tr>
<td>0106</td>
<td>Household Heating &amp; Ventilation (e.g. hoods, ventilators, space heaters)</td>
<td>851621</td>
<td>Heating apparatus; electric storage heating radiators</td>
</tr>
<tr>
<td>0106</td>
<td>Household Heating &amp; Ventilation (e.g. hoods, ventilators, space heaters)</td>
<td>851629</td>
<td>Heating apparatus; electric soil heating apparatus and space heating apparatus (excluding storage heating radiators)</td>
</tr>
<tr>
<td>0108</td>
<td>Fridges (incl. combi-fridges)</td>
<td>841810</td>
<td>Refrigerators and freezers; combined refrigerator-freezers, fitted with separate external doors, electric or other</td>
</tr>
<tr>
<td>0108</td>
<td>Fridges (incl. combi-fridges)</td>
<td>841821</td>
<td>Refrigerators; for household use, compression-type, electric or other</td>
</tr>
</tbody>
</table>
Measure the entire lifecycle
Need data – consumption (Placed on Market)

- Trade statistics and domestic production statistics
- Apparent consumption methodology
- EEE Placed on Market = Domestic Production + Imports - 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

\[
POM(t) = \text{Domestic production}(t) + \text{Imports}(t) - \text{Exports}(t)
\]
Lifespan

- Household and business surveys
- Weibull function
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

- shape 2 scale 5
- shape 2 scale 10
- shape 2 scale 15
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

<table>
<thead>
<tr>
<th>UNU-KEYS</th>
<th>WEIBULL LIFE-TIME DISTRIBUTION IN THE NETHERLANDS, FRANCE AND BELGIUM</th>
<th>WEIBULL LIFE-TIME DISTRIBUTION IN ITALY</th>
<th>PROXY OF WEIBULL LIFE-TIME DISTRIBUTION USED FOR NON EU COUNTRIES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \alpha )</td>
<td>( \beta )</td>
<td>( \alpha )</td>
</tr>
<tr>
<td>0001</td>
<td>2.00</td>
<td>14.21</td>
<td>2.00</td>
</tr>
<tr>
<td>0002</td>
<td>3.50</td>
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<td>15.73</td>
<td>2.58</td>
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<td>1.22</td>
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<td>16.43</td>
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<td>0304</td>
<td>1.68</td>
<td>9.91</td>
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<tr>
<td>0305</td>
<td>1.24</td>
<td>7.22</td>
<td>1.32</td>
</tr>
</tbody>
</table>
E-waste generation

\[ WEEE \text{ Generated} (n) = \sum_{t=t_0}^{n} POM(t) \times L^{(g)}(t, n) \]

- **LIFESPAN OF PRODUCTS SOLD IN 1980**
  - Refrigerators bought in 1980 were mostly disposed of around 1990, but some are still being disposed of even today. The lifespan includes dormant and second-hand use.

- **WEEE GENERATED**
  - Chart showing the generation of WEEE from 1998 to 2020.
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

\[
E \text{ waste generated } (n) = \sum_{t=t_0}^{n} POM (t) \ast L^{(p)}(t, n)
\]
POM-Stock-Flow modelling

LIFESPAN OF PRODUCTS SOLD IN 1980

- Devices bought in 1980 were mostly disposed of around 1990, but some are still being disposed of even today. The lifespan includes dormant and second-hand use.

STOCKS

- The lifespan can be adjusted to match the measured and calculated stock.

EEE POM

WEEE GENERATED

Calculated stock
Measured stock
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])

- Total E-waste generated

- Total E-waste formally collected

- Insert national definitions of e-waste
E-waste statistics toolkit

  - 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
شكراً