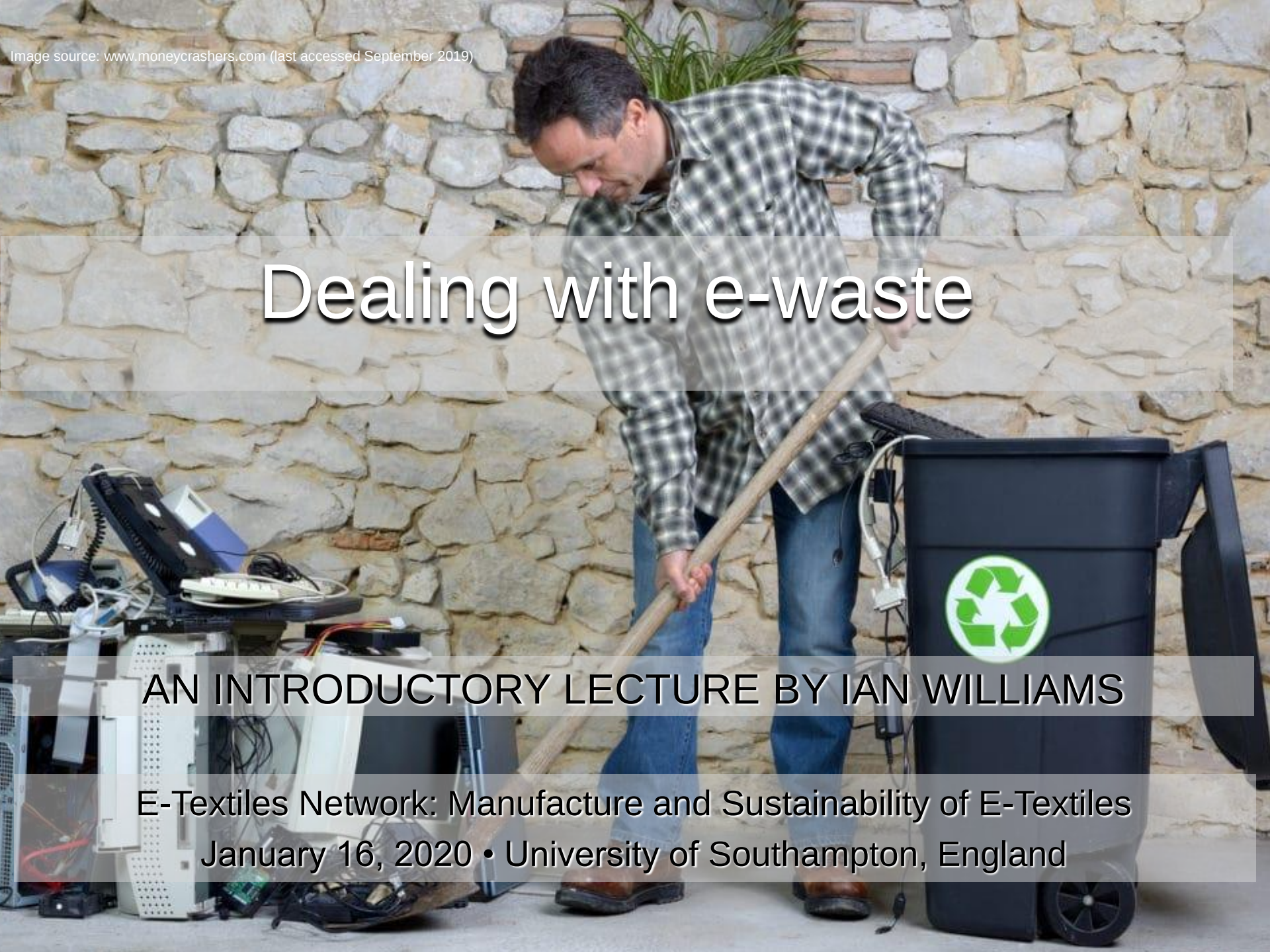


Image source: www.moneycrashers.com (last accessed September 2019)

Dealing with e-waste

AN INTRODUCTORY LECTURE BY IAN WILLIAMS

E-Textiles Network: Manufacture and Sustainability of E-Textiles

January 16, 2020 • University of Southampton, England

EEE (Electrical and electronic equipment)

European Union (Directive 2012/19/EU) definition:

> “equipment which is dependent on electrical currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields and designed for use with a voltage rating not exceeding 1000 Volts for alternating current (AC) and 1500 Volts for direct current” (European Union, 2012)

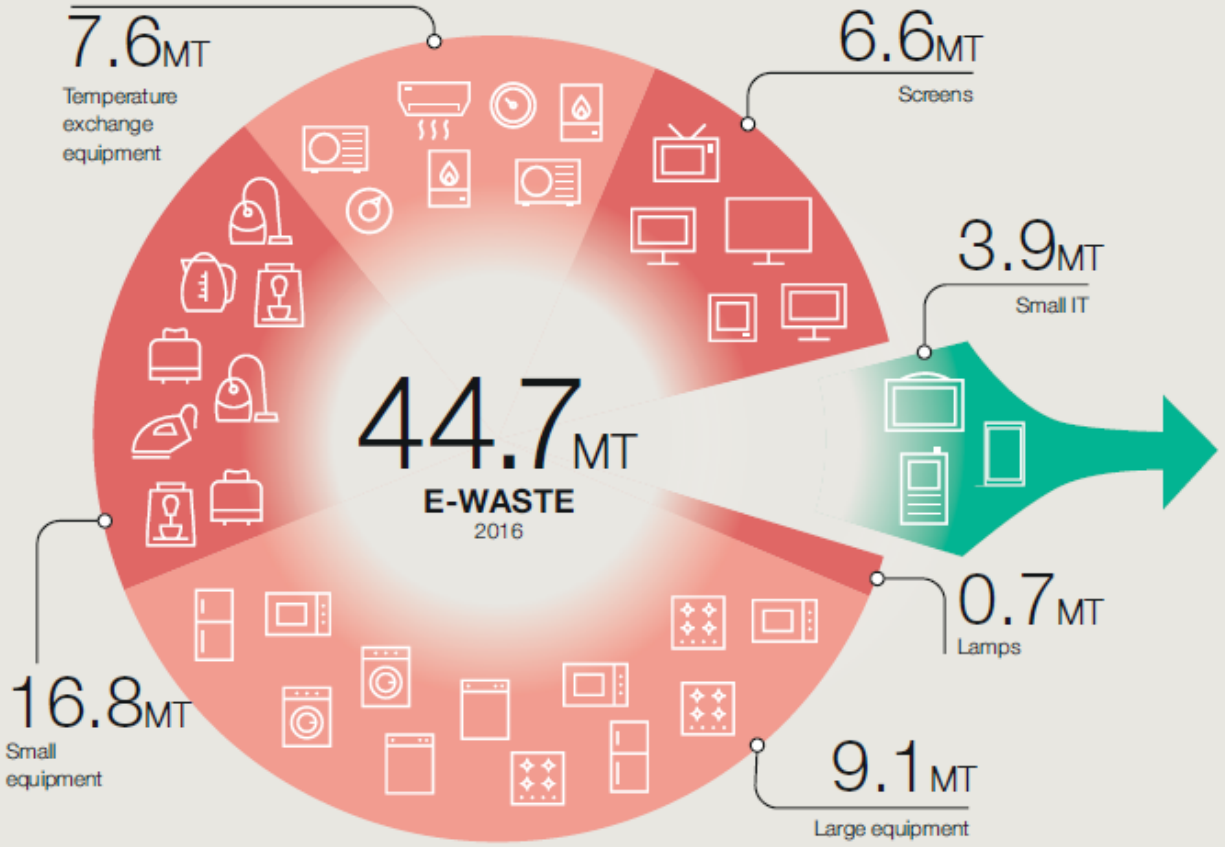
WEEE or “e-waste”

Anything with a plug, electric cord or battery

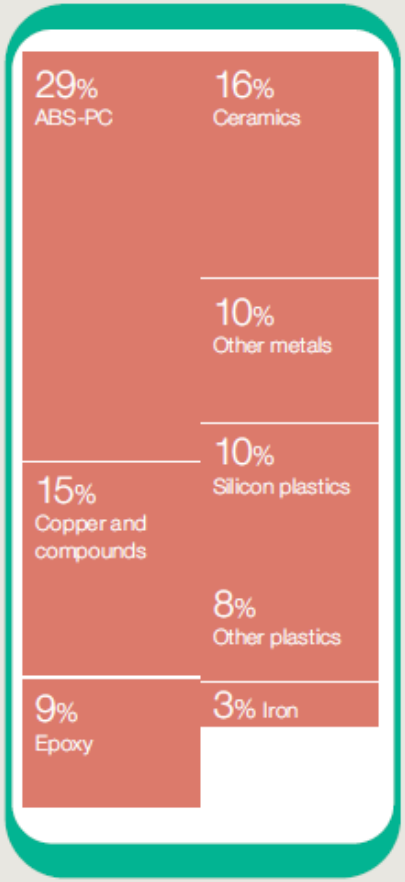
- Complex mixture of materials + components
- Because of hazardous content & if not properly managed can cause major environmental / health problems
- Production of modern electronics requires use of scarce and expensive resources
- To improve environmental management of WEEE, to contribute to circular economy and enhance resource efficiency, improvement of collection, treatment & recycling of electronics at EoL is essential

Modern society involves consumption

WHAT IS E-WASTE?



What's in a typical mobile phone?



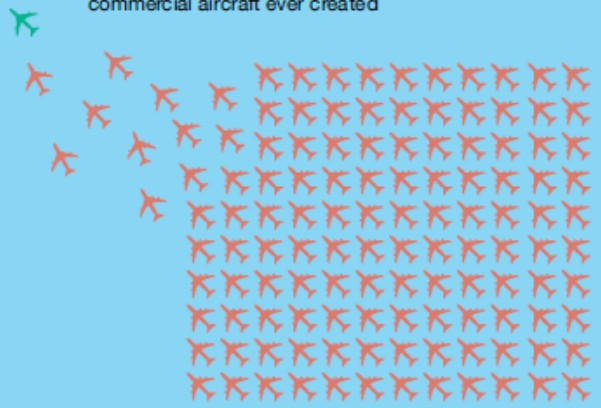
Source: The Global e-Waste Monitor 2017 (http://ewastemonitor.info/) Last accessed November 2018.

HOW MUCH E-WASTE DO WE GENERATE EVERY YEAR?

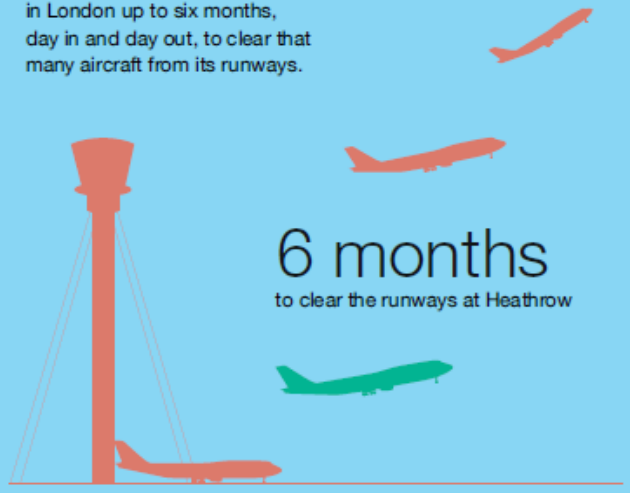
We produce 50 million tonnes of e-waste a year that is the equivalent of....

125,000

jumbo jets which is more than all the commercial aircraft ever created



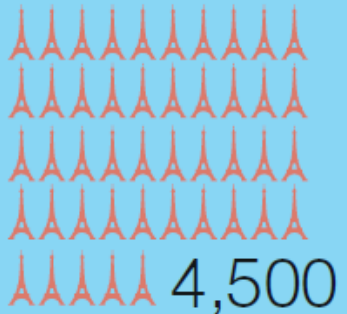
It would take Heathrow Airport in London up to six months, day in and day out, to clear that many aircraft from its runways.



6 months

to clear the runways at Heathrow

This is an equivalent of almost 4,500 Eiffel towers.



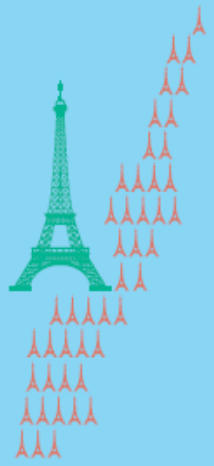
4,500

Eiffel towers

Jam them all in one space, side by side, and they would cover an area the size of Manhattan.

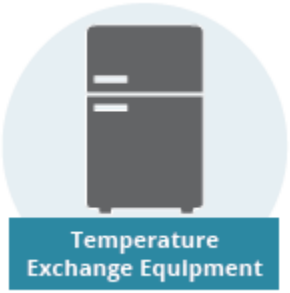
the size of

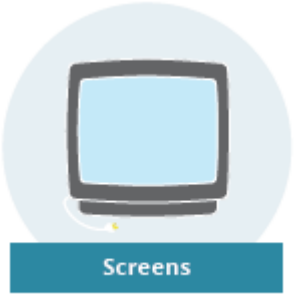
Manhattan

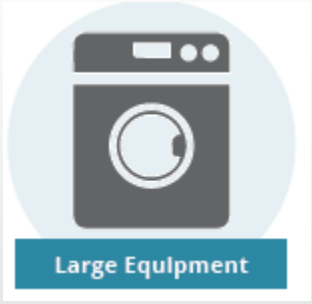


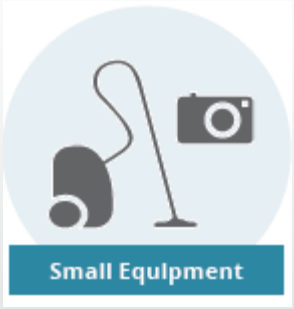
Source: The Global e-Waste Monitor 2017 (http://ewastemonitor.info/) Last accessed November 2018.

WEEE categories





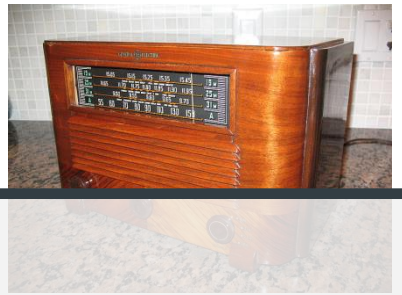




WEEE (or e-waste)

- Unavoidable, huge waste management challenge for developed and developing countries
- Annual growth rate of 4-5%
- WEEE generated in “throwaway societies” via:
  i) Market forces (e.g. technological advances or fashion)
  ii) Consumer behaviour
  iii) Product features (e.g. material composition, condition, or reusability)
  iv) Lack of infrastructure/services to collect WEEE
- Challenge to promote slower rate of consumption and to increase reuse of EEE

Evolution of the radio



- Steady technological advances
- Relatively slow evolution of product with long lifetime
- Slow change in complexity, number of elements in product and number of users
- Relatively minor consequences for waste management
- Move from analogue to digital radio

Evolution of mobile phones

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1980s

1997-2004

2011

- Rapid technological advances
- Rapid evolution of product and functionality with increasingly short lifetime
- Rapid increase in complexity, number of elements used in product and number of users
- Steadily increasing consequences for waste management

1991

2007

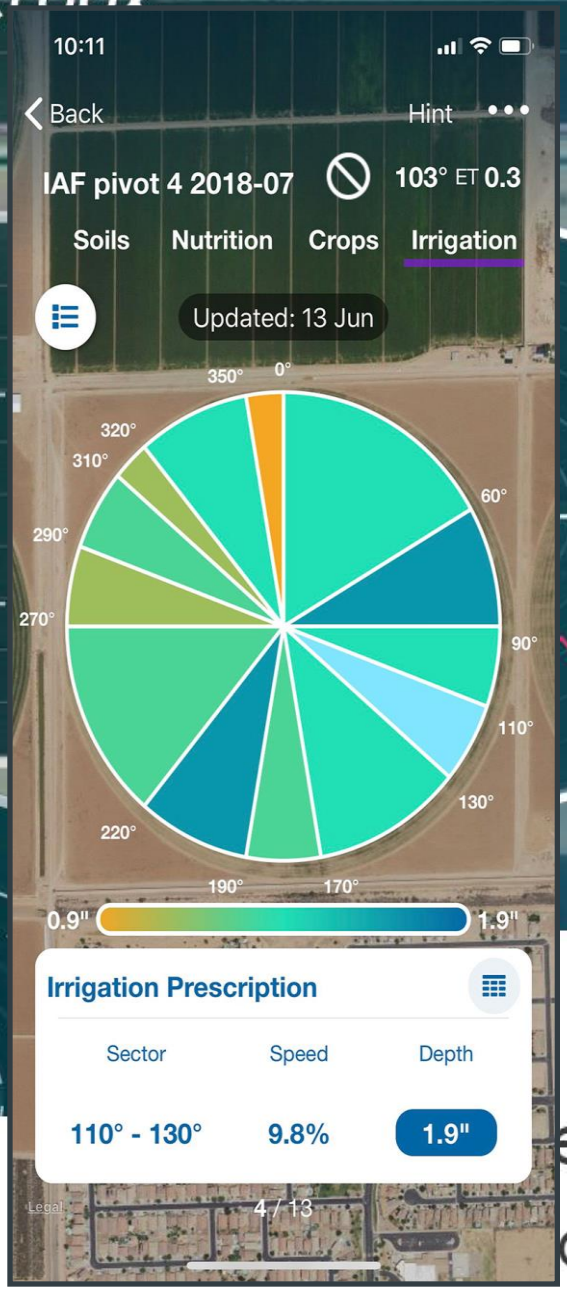
2019

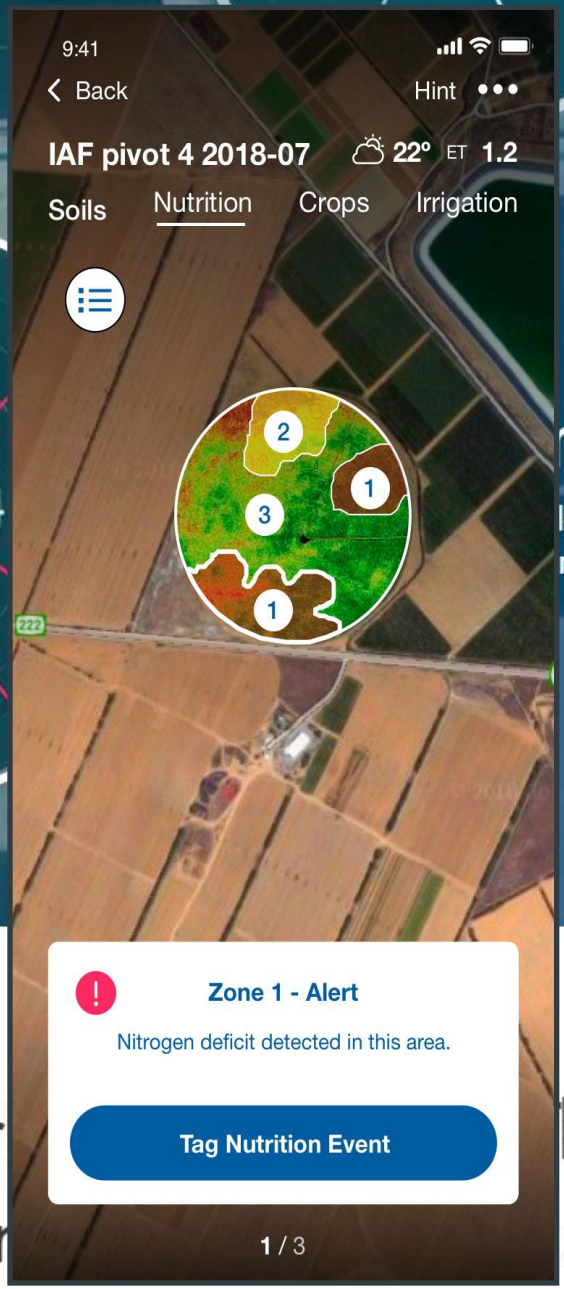
Results: Evolutionary Timelines

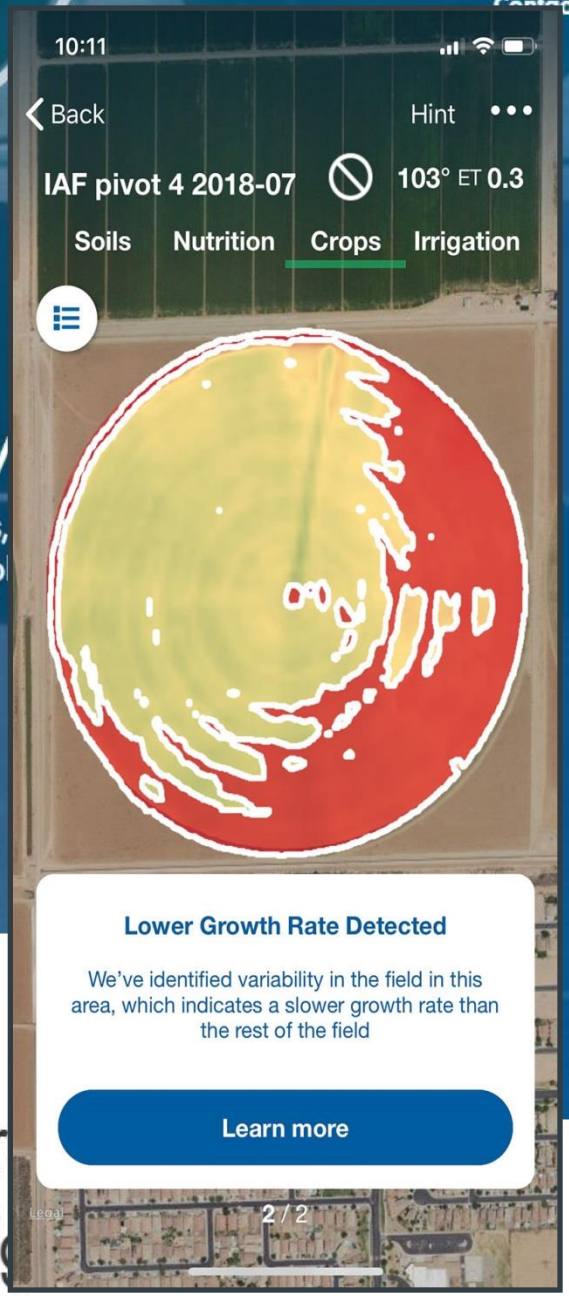
- Very rapid technological advances
- Very rapid evolution of product and functionality with increasingly short lifetime
- Huge increase in complexity, number of elements used in product and number of users
- Very significant consequences for waste management

Delivering Instant Value Through Actionable, Impactful insights

Source: www.cropx.com







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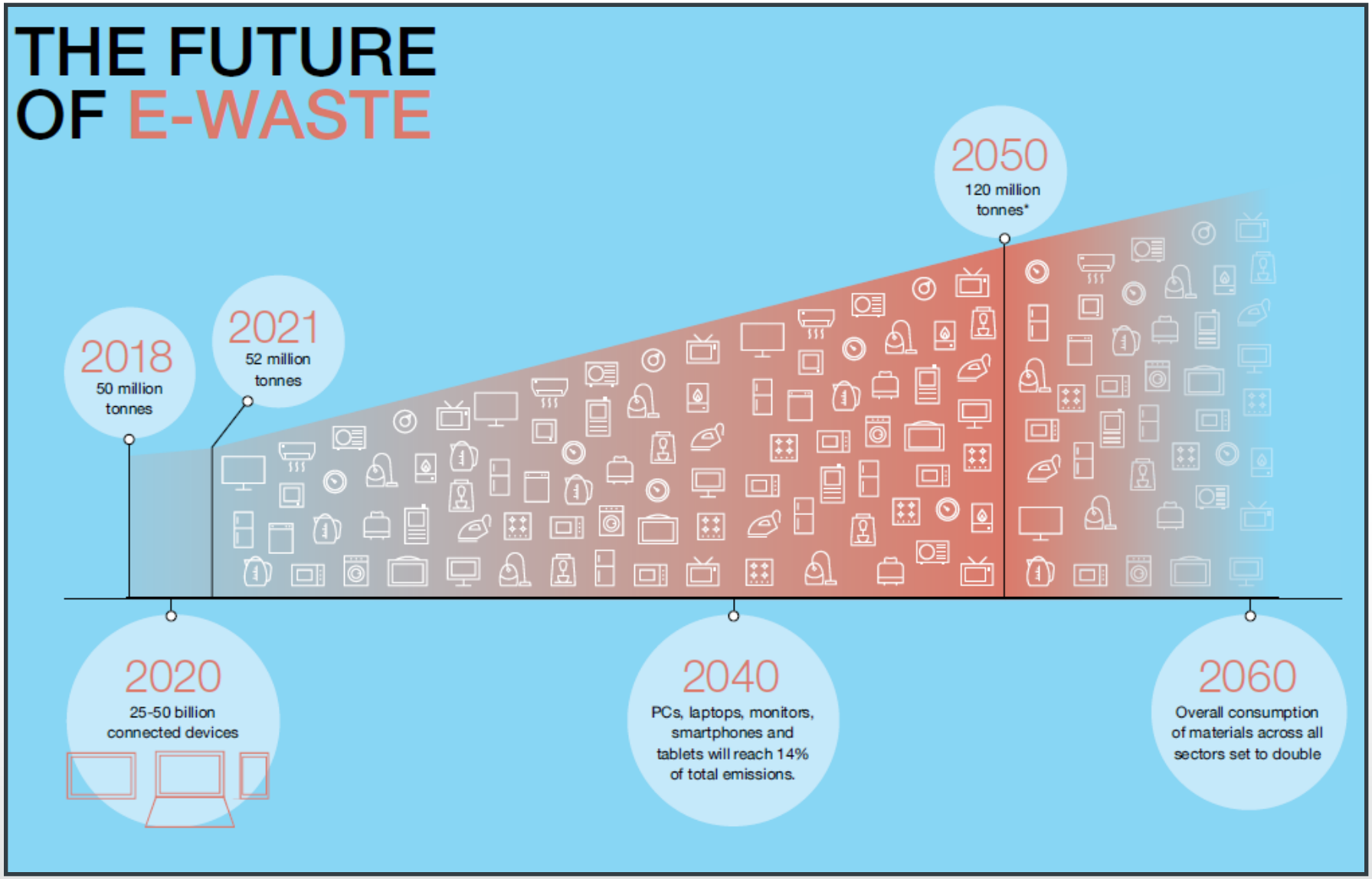
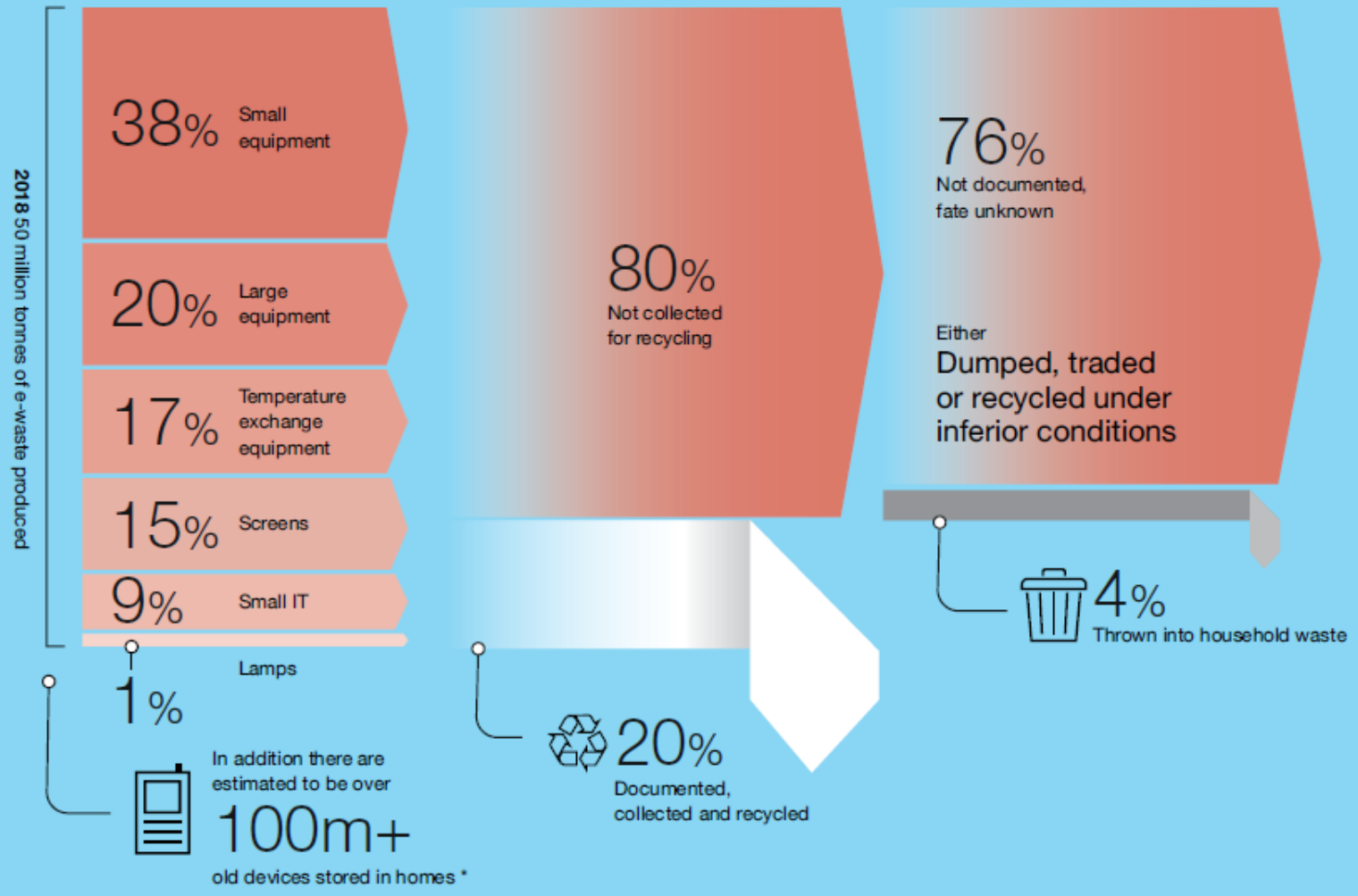


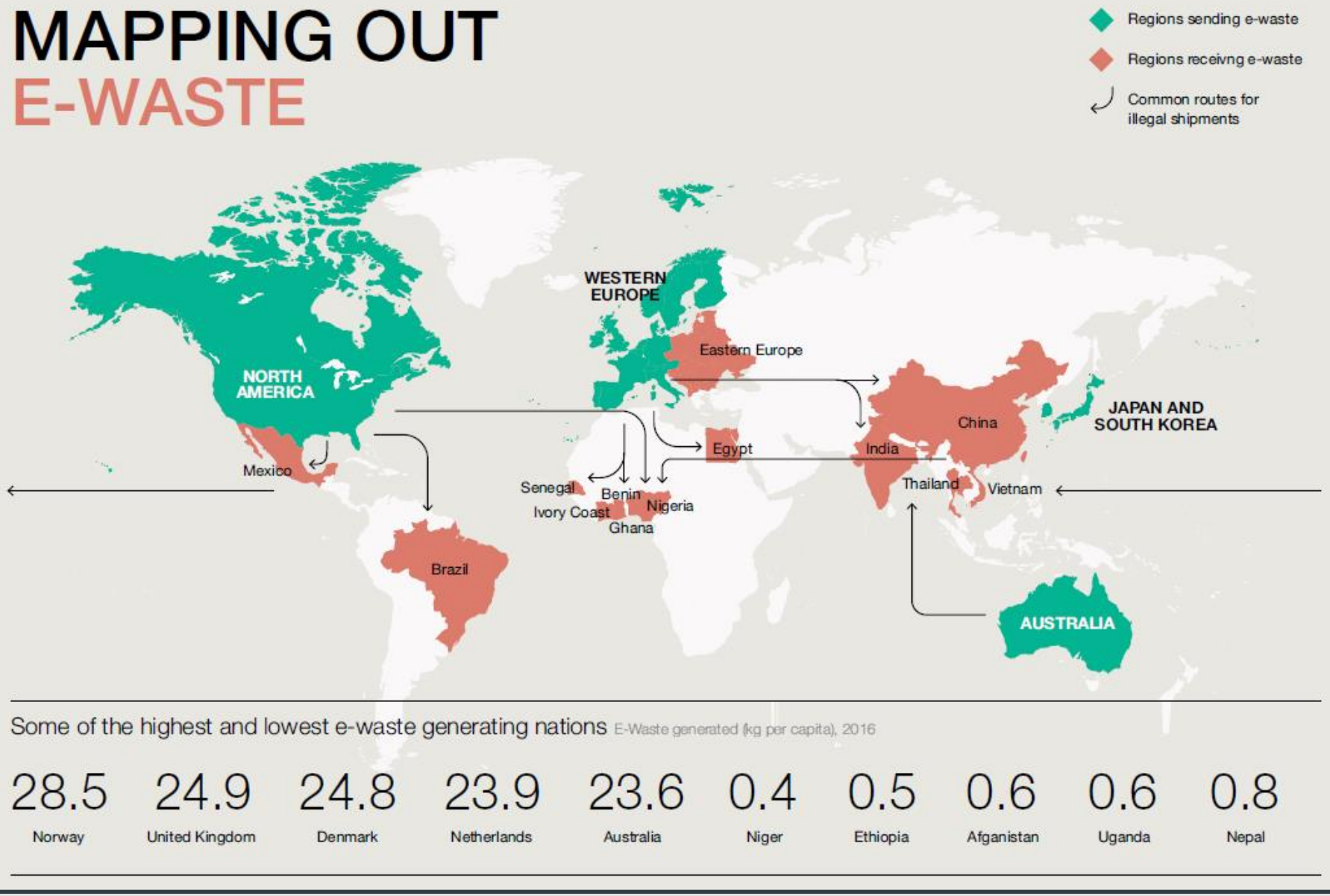
Source: The Global e-Waste Monitor 2017 (http://ewastemonitor.info/) Last accessed November 2018.

GLOBAL E-WASTE FLOWS



Source: The Global e-Waste Monitor 2017 (http://ewastemonitor.info/) Last accessed November 2018.

MAPPING OUT E-WASTE



Some of the highest and lowest e-waste generating nations E-Waste generated (kg per capita), 2016

28.5	24.9	24.8	23.9	23.6	0.4	0.5	0.6	0.6	0.8
Norway	United Kingdom	Denmark	Netherlands	Australia	Niger	Ethiopia	Afganistan	Uganda	Nepal

Source: The Global e-Waste Statistics Partnership 2018

E-waste management

- Approach 1:
  - Documented and official collection in accordance to statutory requirements
  - Collection via municipal collection points, EEE producers and retailers or via dedicated pick-up arrangements
  - E-waste collected transported to specialised treatment facilities
  - Treated via processes (including manual disassembly, shredding and materials recycling) under controlled conditions to ensure environmentally sound manner of treatment

E-waste management

- Approach 2:
  - Characterised by direct disposal of E-waste together with regular household waste (commingled waste)
  - Consumers dispose of E-waste together with non-segregated household waste
  - Comingled waste ends up landfilled or incinerated

E-waste management

- Approach 3:
  - Involves unofficial collection of E-waste
  - Waste brokers and dealers
  - Outcomes include recycling of E-waste at specialist facilities, refurbishment or exportation to developing countries
  - E-waste in this scenario not officially documented, making generation and collected amounts difficult to track
  - Due to absence of legal requirements or framework E-waste management
  - Treatment not environmentally sound or may end up exported illegally

E-waste management

- Approach 4:
  - Prevalent in developing countries
  - Involves informal collection of E-waste
  - Activities not regulated - absence, or no enforcement of legislation
  - Treatment methods basic and crude - open burning and acid leaching for metal extraction
  - Involves reuse, repair and cannibalising E-waste for parts, also occurs within Europe


Impacts of e-waste

Unregulated and Untreated, WEEE leads to Environmental Risks

- Substances contained in WEEE:
  - Greenhouse gases
  - CFCs
  - Metals
  - Flame retardants
- Can lead to risks for human health + the environment:
  - Global warming
  - Destruction of the ozone layer
  - Leakages from landfills into water and soil
  - Possible formation of new hazardous substances during incineration

Massive adverse environmental impacts in developing countries

"In its lifetime a typical microwave will use more power to Illuminate its digital clock than it will use for actually cooking food"

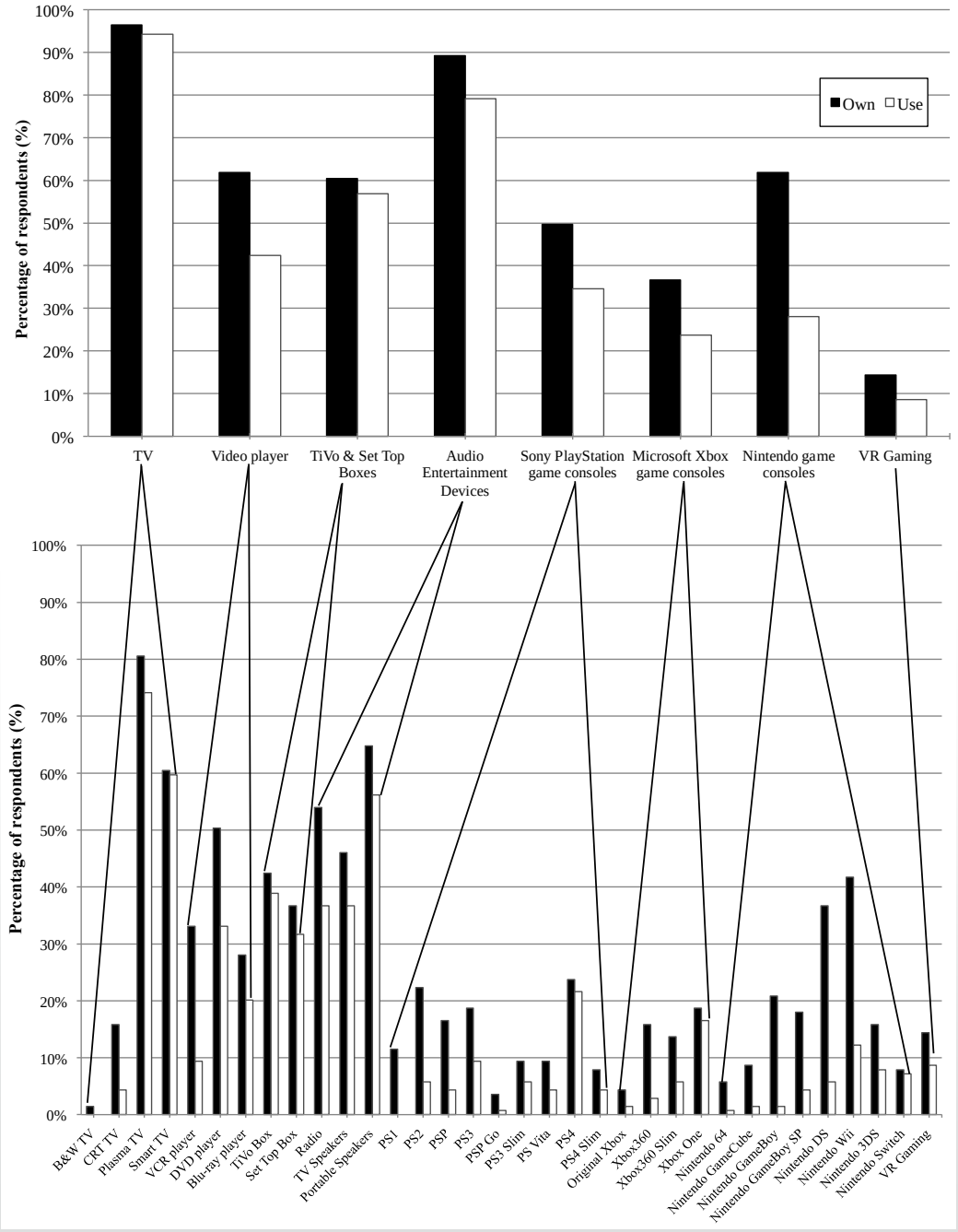
Household EEE Stock (Data BEL)

Total: 79 EEE + 47 Lamps/Luminaires per HH (B2C) // + 36 EEE per HH (B2B)

Total Stock = 263 kg/inh.

WEEE Hoarding

- Hoarding - consumers indefinitely store obsolete EEE that are no longer used or wanted
  - Major barrier to releasing exploitable materials into CE
- Average household in USA hoards 4.1 small and 2.4 large EEE in attic or basement
- Europe: hoarding common for (W)EEE with perceived residual value (monetary, functional, sentimental)
- Hoarded items currently unavailable (hibernating stocks) reduce exploitation potential of anthropogenic resources
- (W)EEE should be stockpiled/hoarded with intent of releasing it into CE to ensure access to DUM's stocks



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Proportion of respondents owning and using at least one home entertainment electronic product in Southampton in 2018 (n=139).

Total number of home entertainment items hoarded by respondents (n=104).

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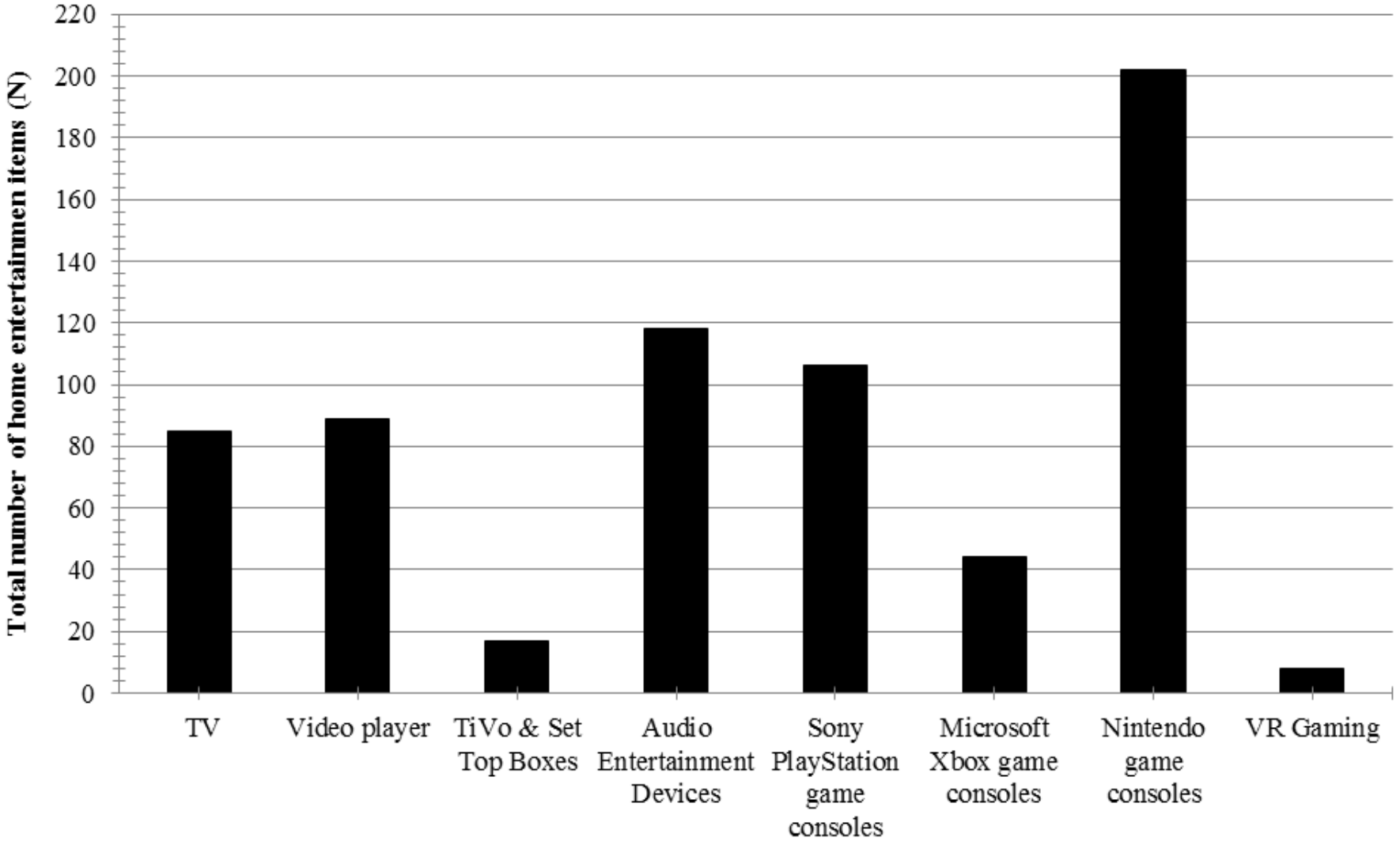

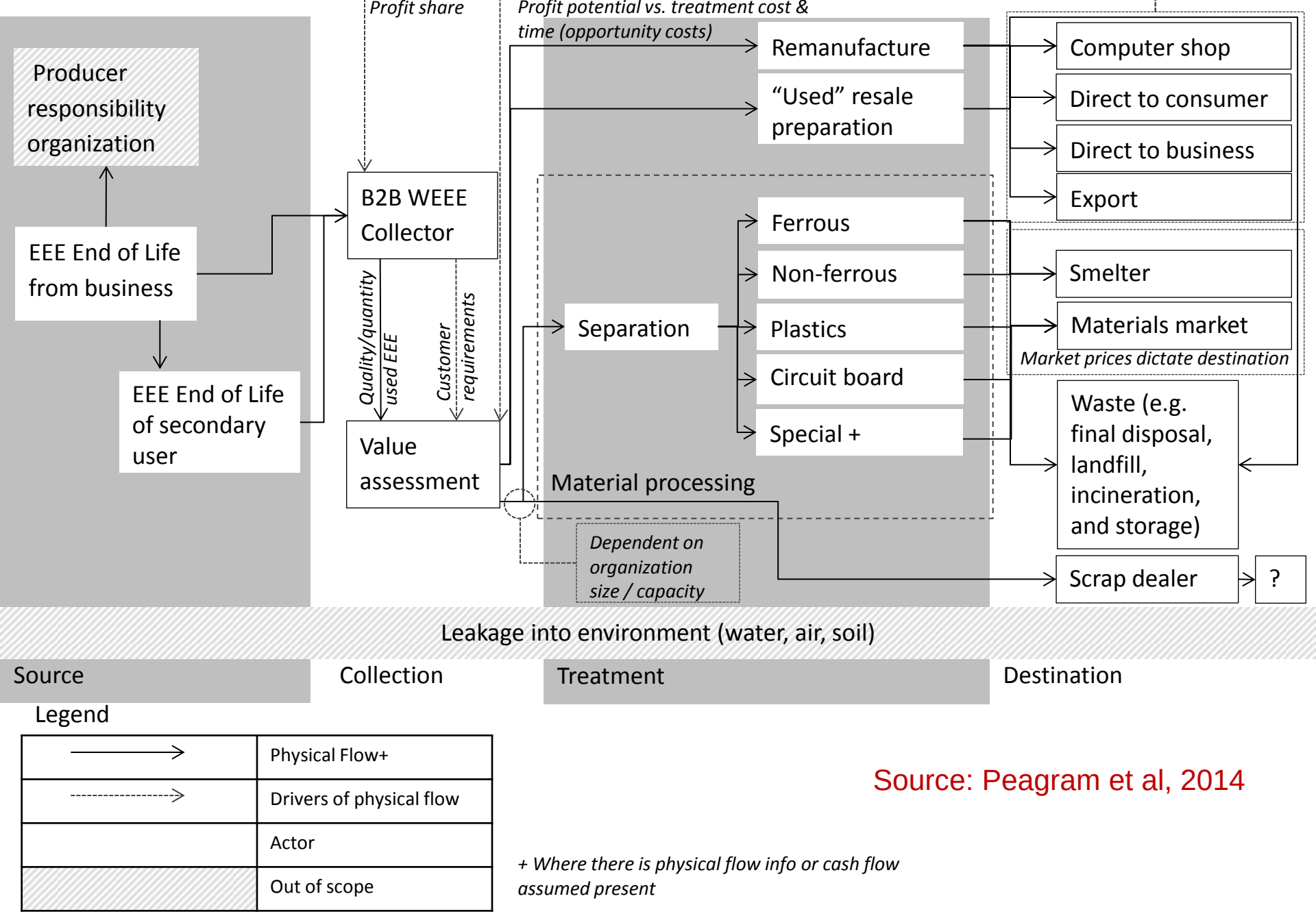

Legend

→	Physical Flow+
⇢	Drivers of physical flow
	Actor
	Out of scope

+ Where there is physical flow info or cash flow assumed present

Source: Peagram et al, 2014

Drivers of materials flow for business to business (B2B) WEEE from collection through treatment for reuse or recycling. Special+ includes unusual (one-off) or non-standard items. "Leakage into the Environment" is possible from every step, to simplify the illustration, the arrows are not plotted.

We Need a WEEE Circular Economy!

- Resources within WEEE - plastics, glass, metals - recovered, reducing need for extraction of raw materials
- Modern high-tech EEE rich in metals + critical raw materials; large proportion of anthropogenic stocks
- Secondary resources may be exploited via urban mining
- Ideal locations for urban mining – Distinct Urban Mines - include urban hubs, localised populations, quantifiable anthropogenic (W)EEE stocks and material flows
- Material stocks - in-use and hibernating (hoarded or stockpiled) (W)EEE in society
- Material flows - involve reuse, recycling and discarding of EoL electronics

Conclusions

- To ensure recovery of used EEE and WEEE, waste management efforts should:
  - Promote recycling and reuse through awareness campaigns on collection schemes for consumer electronics
  - Establish convenient and accessible used EEE and WEEE collection points to encourage regular (periodic) harvesting
  - Establish incentives.to encourage reuse / recycling behaviour, with potential monetary incentives
  - Target recovery of items that take up more space in consumer households
  - Encourage faster reuse of EEE via donations to charities, relatives or friends in order to gradually stimulate consumers to view EoL WEEE differently

Dealing with e-waste

THANK YOU FOR YOUR ATTENTION

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