THE WEEE JUNGLE - the (electronic) urban mining

RawMaterials RM@Schools

ECODOM
Consorzio Italiano
Recupero e Riciclaggio
Elettrodomestici

This activity has received funding from the European Institute of Innovation and Technology (EIT). This body of the European Union receives support from the European Union's Horizon 2020 research and innovation programme.

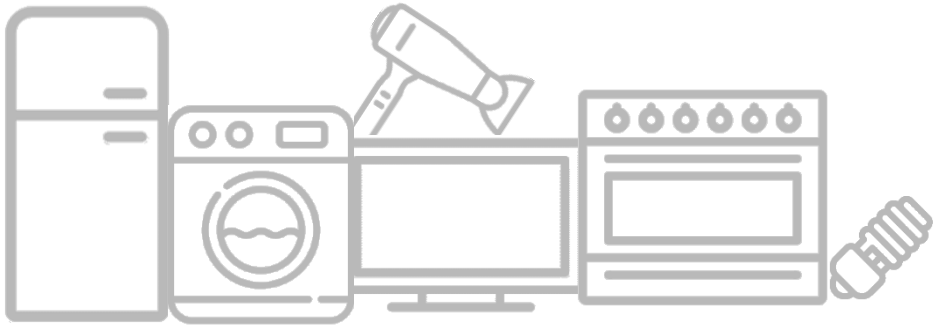
Introduction

What does EEE stand for?

Electrical &

Electronic

Equipment



EEE:

Equipment dependent on **electric currents** or **electromagnetic fields** in order to work properly

What does WEEE stand for?

Waste

Electrical &

Electronic

Equipment

WEEE:

is a **EEE** that has come to the

end of its "user-phase" → e-waste

The WEEE streams

C&F refrigeration and air-conditioning

LHA large household appliances

TV&Screens

SHA small household appliances

Lamps

The WEEE system

The legislative framework

European Directive 2012/19/EU on WEEE

- Protects the environment and human health by preventing or reducing the production of WEEE.

GREEK LEGISLATION

Decision 133480

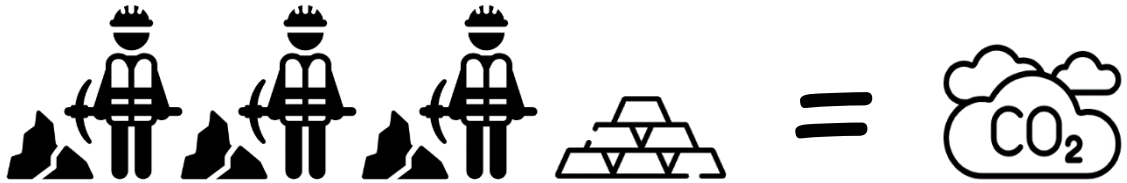
- Rules , terms and conditions for the Alternative Management of Waste Electrical and Electronic Equipment (WEEE) , in compliance with the provisions of Directive 2012/19/EU).

Ministerial Decision 23615/651/E.103

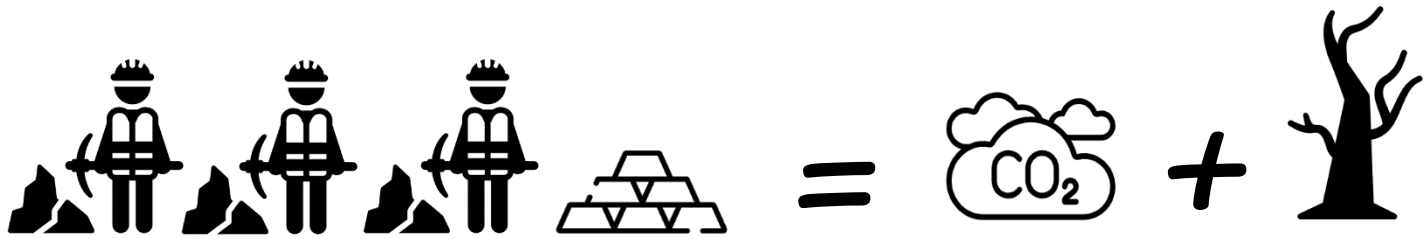
- It transposes the European Directive 2012/19/EU to the Greek Legislation of WEEE.

When my... does not work anymore

If you keep it in a drawer, then...

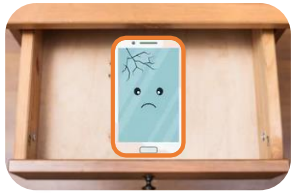


If you throw it in the trash, then...



How should I get rid of...?

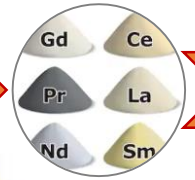
Story 1: REMO



LANDFILL DISPOSAL

LINEAR ECONOMY

MINING ACTIVITIES



PRODUCERS
(Es. Samsung / Apple)

RETAILERS

Story 2: ROMOLO

MUNICIPAL COLLECTION POINT

WEEE TREATMENT PLANT

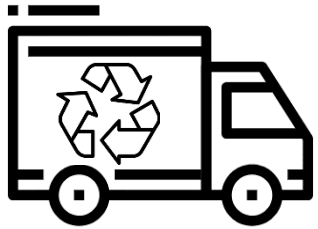
SMELTER

PRODUCERS
(Es. Samsung / Apple)

RETAILERS

CIRCULAR ECONOMY

How to properly dispose of my...

1. 

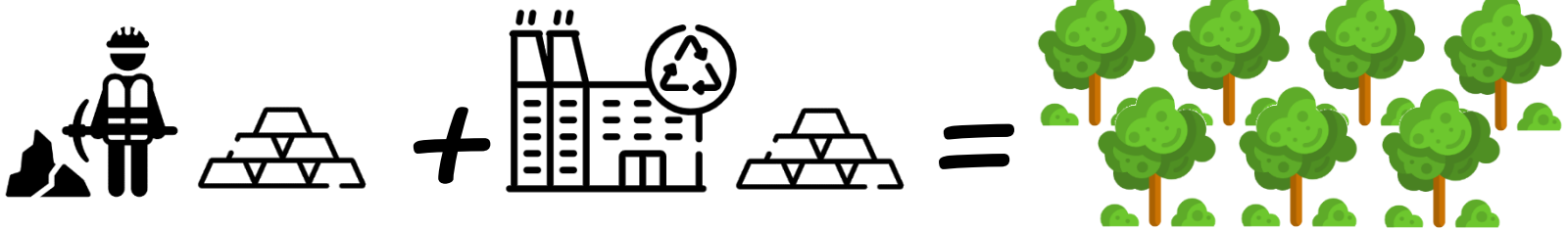
Municipal collection service

2. 

Municipal collection points

3. 

Retailers



Who will take care of my... ?

Manufacturers are responsible for the management of **WEEE.**

And they do it by establishing:

COMPLIANCE SCHEMES

TRANSPORT

TREATMENT

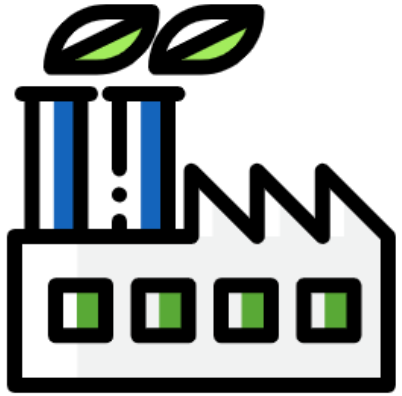
In Italy, **ECODOM** is the largest Compliance Scheme.

In Greece, the analogous is **appliances recycling s.a.**

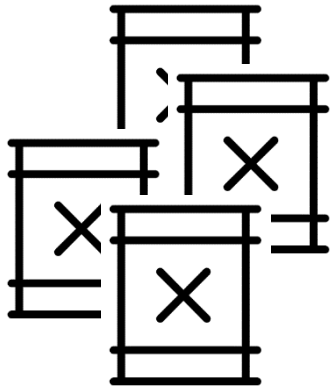
ανακύκλωση συσκευών α.ε. / appliances recycling s.a.

What can be achieved from WEEE recycling?

WEEE treatment: overview



Hazardous substances removed



Valuable fractions collected

Energy recovery
Material recycling
Residues disposal

Secondary Raw Materials

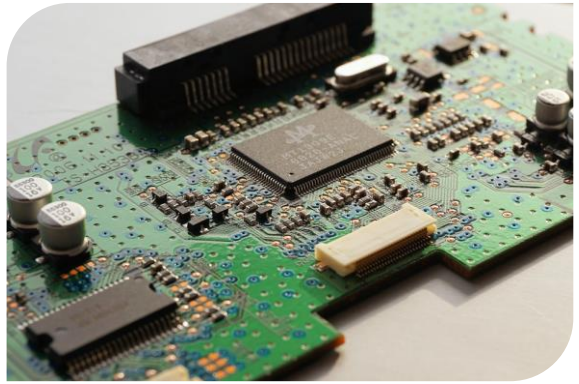
Hazardous substances → RISKS

CFC/HC
[chlorofluorocarbon hydrocarbon]

OILS

Batteries
[Pb, Cd, Hg, Cr^{6+}]

PCBs
[Printed Circuit Boards]



Separated and properly secured

Valuable components → SUCCESS

PLASTICS

ALUMINUM

+

Critical Raw Materials (CRMs)

IRON

COPPER

The recovery rate

RECOVERY = MATERIAL RECOVERY + ENERGY RECOVERY = MR + EV

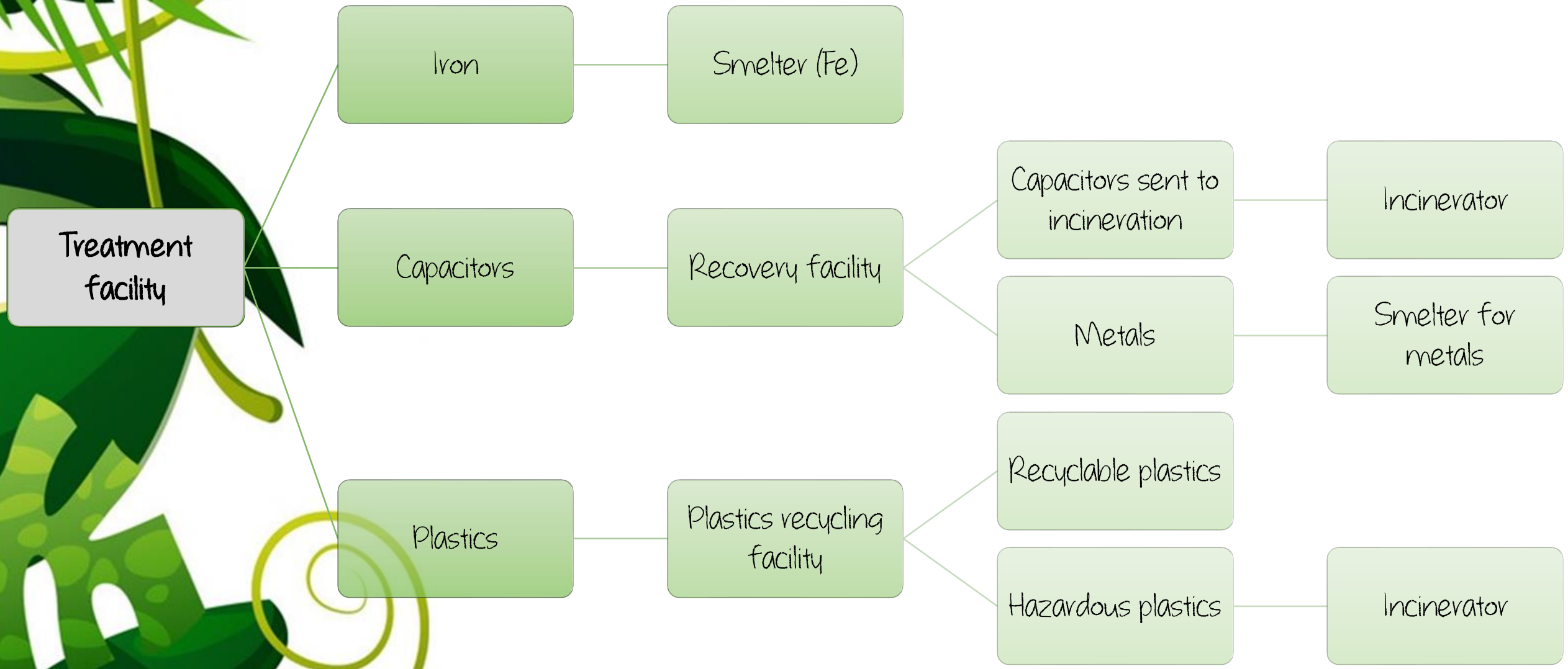
Example of energy **recovery**: the polyurethane sent to incineration is burnt

→ the heat generated is used to produce electric power and to heat water.

REUSE AND RECYCLING = MATERIAL RECOVERY = MR

Example of **recycling**: the iron extracted from refrigerators' treatment is sent to smelters to become "new" iron.

Recovery rate: PROCESS FLOW



The recovery rate

What the legislator ask for?

We must look at Directive 2012/19/EU of the European Parliament

5: Minimum targets applicable by category from 15 August 2018 with reference to the categories listed in Annex III:

(a) for WEEE falling within category 1 or 4 of Annex III,

— 85 % shall be recovered, and

— 80 % shall be prepared for re-use and recycled;

(b) for WEEE falling within category 2 of Annex III,

— 80 % shall be recovered, and

— 70 % shall be prepared for re-use and recycled;

(c) for WEEE falling within category 5 or 6 of Annex III,

— 75 % shall be recovered, and

— 55 % shall be prepared for re-use and recycled;

(d) for WEEE falling within category 3 of Annex III, 80 % shall be recycled.

For example, for WEEE falling within **category 1 or 4** it is required:

RM+VE = 85% RECOVERY = MATERIAL RECOVERY + ENERGY RECOVERY = MR + EV

RM = 80% REUSE AND RECYCLING = MATERIAL RECOVERY = MR

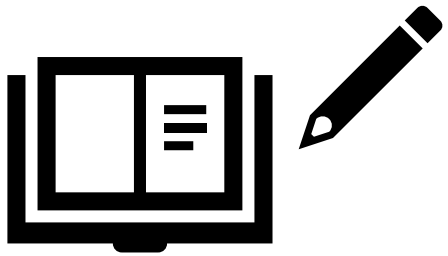
Recovery and disposal

Example:

category R1

Components	Material Recovery	Energy Recovery	Incine-ration	Landfill Disposal
Aluminum	3.10%			
Other metals	0.60%			
CFC / HC			0.60%	
Capacitors			0.00%	0.00%
Wood	0.50%			
Ferrous metals	61.20%			
Oils	0.40%			0.00%
Plastics	13.90%	0.20%	0.00%	0.30%
Polyurethane	0.30%	11.90%		1.90%
Copper	2.20%			
Non-hazardous wastes		0.10%	0.00%	1.70%
Hazardous wastes				0.00%
Glass	1.10%			0.00%
Total	**83.30%**	**12.20%**	**0.60%**	**3.90%**

TIME TO EXERCISE



Recovery and disposal

Declaration

Cooling and freezing R1

Aluminum Smelter S.A.

Dear ESEE Education,

Hereby it is stated that 100% of the aluminum we received from you was processed for the production of aluminum bars.

Best Regards

/CEO

Aluminum Smelter S.A.

Recovery and disposal

Solutions for R1 → cooling and freezing

R1 STREAM

Components	Total weight [kg]		Weight [kg] Material Recovery	Energy Recovery	Incineration	Landfill disposal	Percentages [%] Material Recovery	Energy Recovery	Incineration	Landfill disposal
Aluminum	1,148,166	of which:	1,148,166				3.1%			
Other metals	97,927	of which:	97,927				0.3%			
CFC/HC	225,557	of which:	660	77	224,820		0.002%	0.0%	0.6%	
Capacitors	8,267	of which:			679	7,588			0.002%	0.02%
Wood	143,522	of which:	143,522				0.4%			
Oils	132,351	of which:	131,040			1,311	0.4%			0.004%
Plastics	5,484,440	of which:	5,425,860	49,545	270	8,765	14.6%	0.1%	0.001%	0.024%
Polyurethane	5,121,150	of which:	116,383	4,239,114	83,032	682,621	0.3%	11.4%	0.2%	1.837%
Copper	856,712	of which:	856,712				2.3%			
Glass	437,920	of which:	437,920				1.2%			
Non-hazardous wastes	1,113,831	of which:			9,663	1,104,168			0.026%	3.0%
Ferrous metals	22,373,682	of which:	22,373,682				60.2%			
Hazardous wastes	11,833	of which:				11,833				
TOTAL	**37,155,358**	of which:	**30,731,872**	**4,288,736**	**318,464**	**1,816,286**	**82.7%**	**11.5%**	**0.9%**	**4.9%**

EU MANDATORY TASK:

RECOVERY rate: 85%

RECYCLING rate: 80%

Recovery and disposal

Solutions for R3 → screen

R3 STREAM

Components	Total weight [kg]		Weight [kg] Material Recovery	Energy Recovery	Incineration	Landfill disposal	Percentages [%] Material Recovery	Energy Recovery	Incineration	Landfill disposal
Aluminum	153	of which:	153				0.3%			
Other metals	635	of which:	635				1.1%			
Capacitors	46	of which:				46				0.1%
Wood	880	of which:	880				1.5%			
Ferrous metals	6,140	of which:	6,140				10.6%			
Plastics	9,554	of which:	9,289	1	250	14	16.0%	0.002%	0.4%	0.0%
Copper	4,701	of which:	4,701				8.1%			
Glass	18,621	of which:	18,621				32.1%			
Cone glass	15,545	of which:	8,950			6,595	15.4%			11.4%
Non-hazardous wastes	1,549	of which:		36	335	1,178		0.1%	0.6%	2.0%
Hazardous wastes	208	of which:				208				0.4%
TOTAL	**58,032**	of which:	**49,369**	**37**	**585**	**8,041**	**85.1%**	**0.1%**	**1.0%**	**13.9%**

EU MANDATORY TASK:

RECOVERY rate: 80%

RECYCLING rate: 70%

CRMs
Critical Raw Materials in WEEE

What are CRMs?

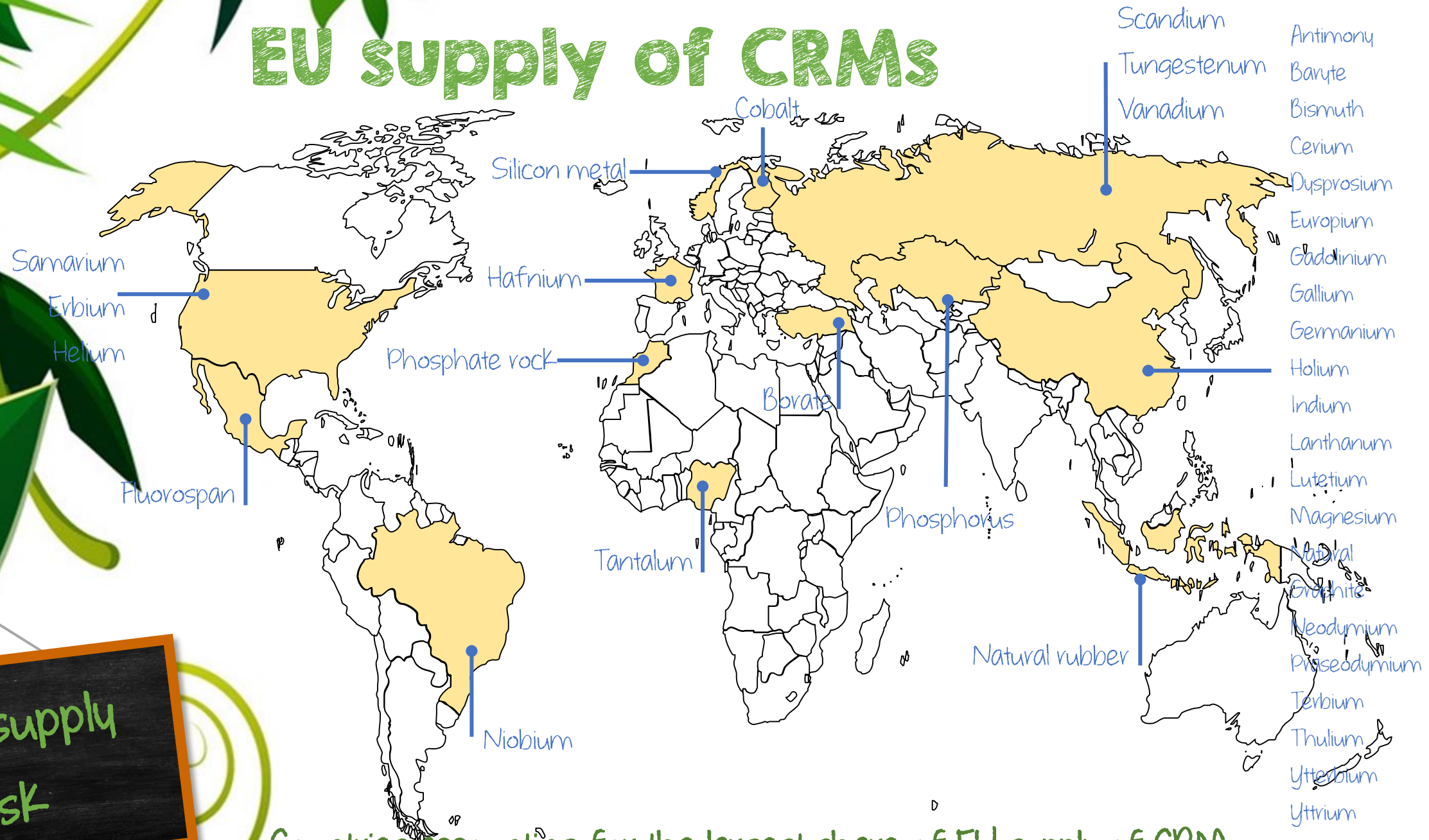
CRMs [=CRITICAL RAW MATERIALS] are raw materials classified by the European Commission as "**CRITICAL**".

The main parameters used to determine the **criticality** for the EU Commission are:

- high economic importance to the EU;
- high risk associated with their supply.

In 2017, the European Commission published the **3rd list of 27 CRMs**.

EU supply of CRMs

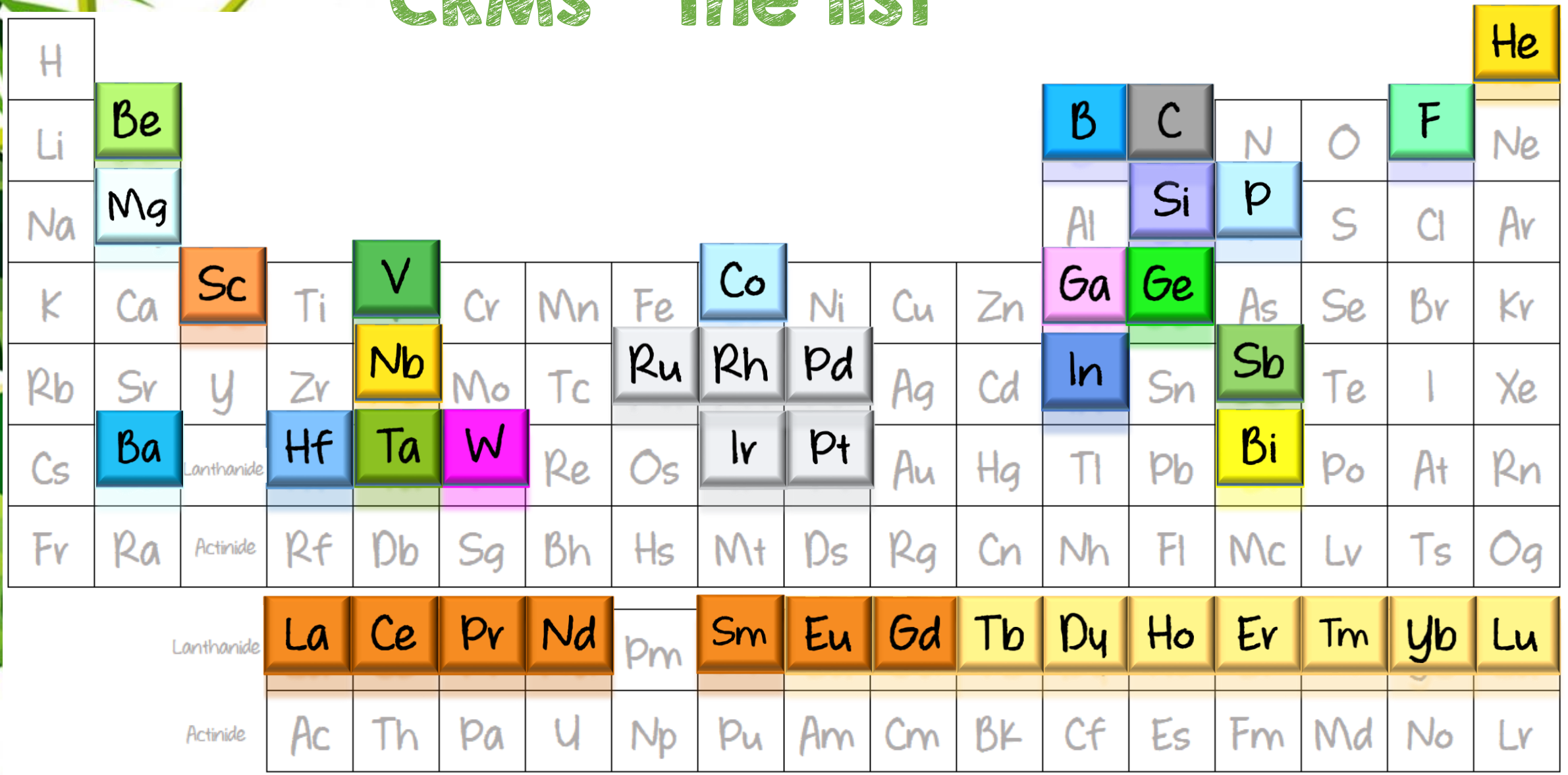


The supply risk

Countries accounting for the largest share of EU supply of CRM

Source: http://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical_it

CRMs - the list



PGM Platinum Group metals

LREE Light Rare Earth Elements

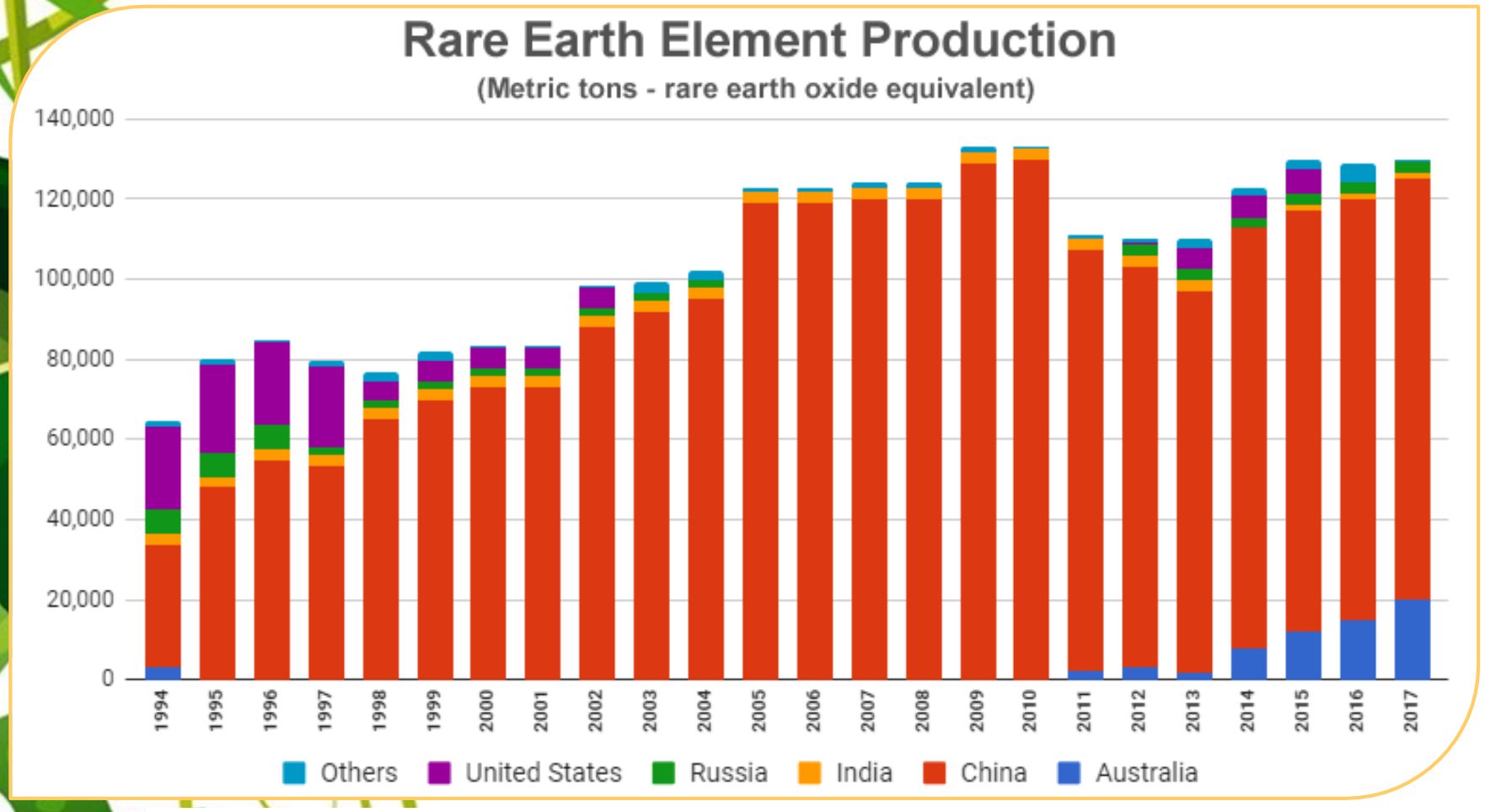
HREE Heavy Rare Earth Elements

REEs ore deposits

Despite many known REE deposits, the global supply of REEs is limited by the cost and complexity of exploring REE deposits and developing REE mines, including REE extraction and separation facilities.

Source: Los Alamos National Laboratory Chemistry Division; 2018

REEs supply history



Since 2010, new researches to look for new deposits of Rare Earth Elements developed. And new initiatives for recycling REEs from WEEE started.

PRODUCING COUNTRIES

- CHINA: more than 90%
- AUSTRALIA
- UNITED STATES
- RUSSIA
- INDIA

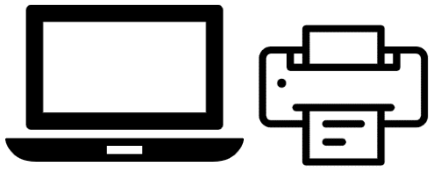
RARE EARTH ELEMENTS are in the list of CRITICAL RAW MATERIALS since 2014

Source: geology.com su dati dello USGS (United States Geological Survey)

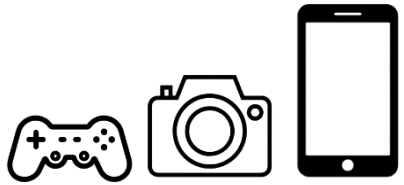
CRMs in WEEE → think about

WEEE streams containing CRMs:

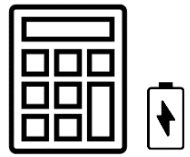
Displays
(tipically LCD screens)



ICT



Consumer electronics



Small mixed WEEE
(including batteries)

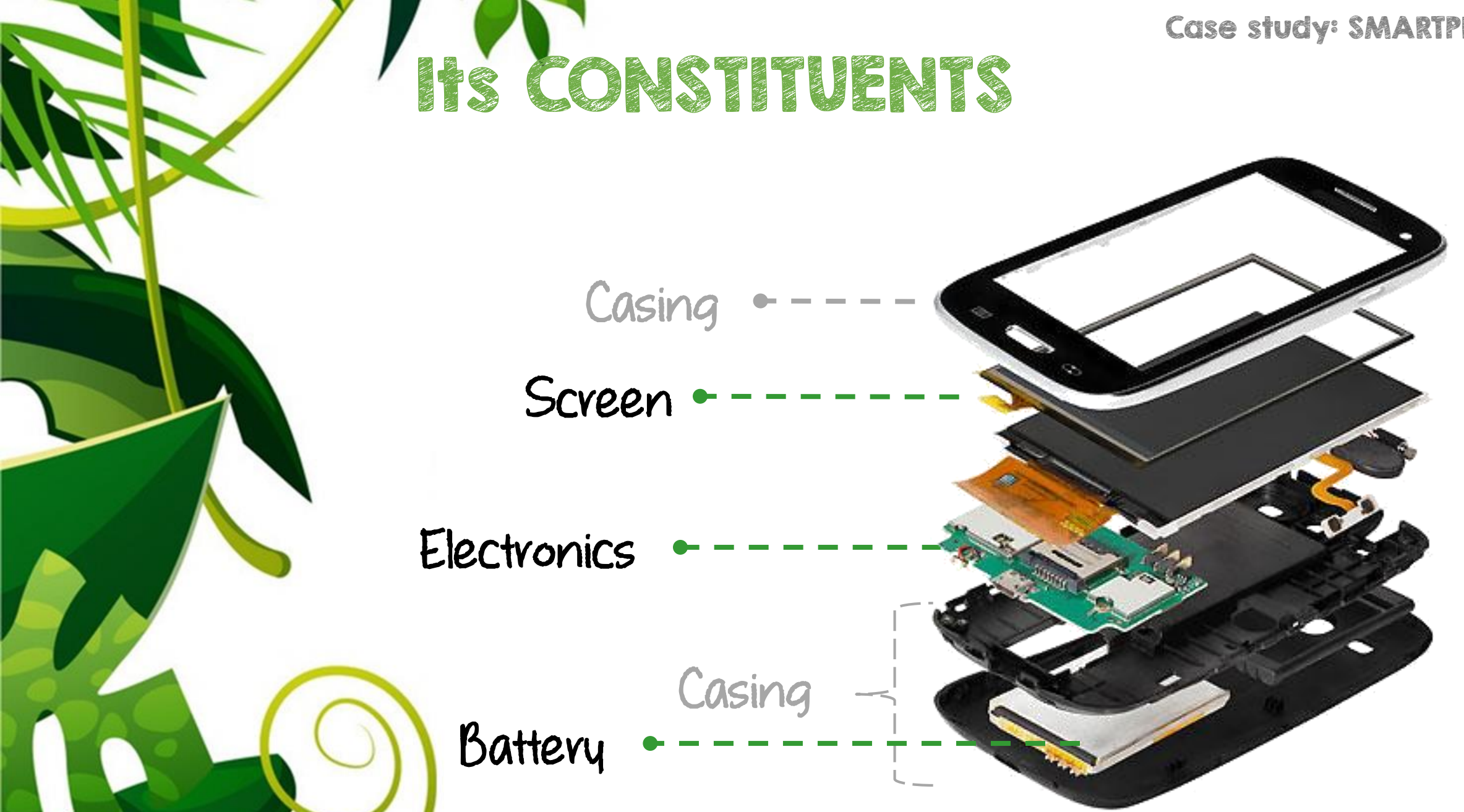
of WEEE is generated every year in the world...

... but only is properly managed

Source: CRM Closed Loop Recovery (WRAP) & The global E-waste monitor 2017 (UNU)

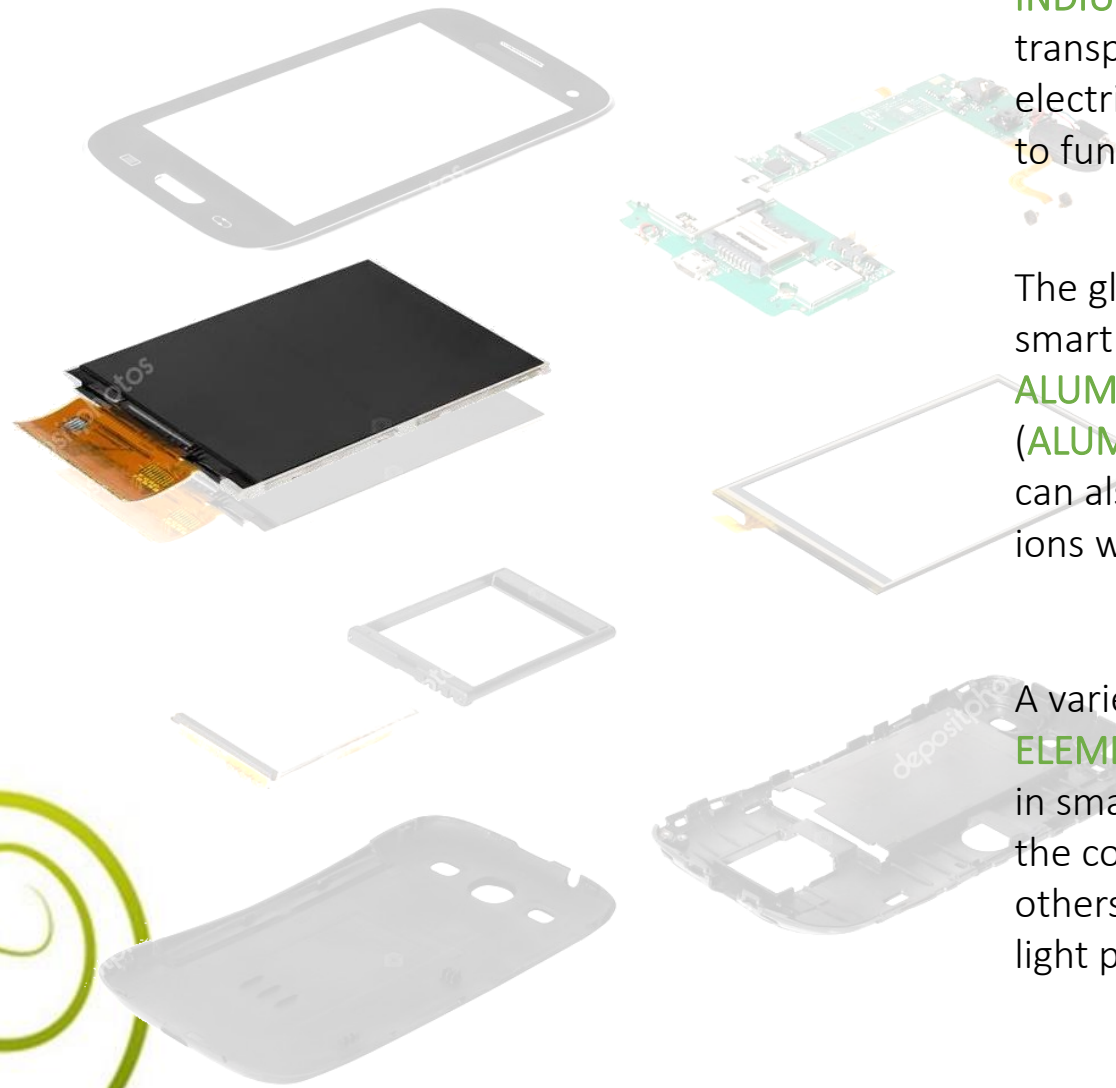
Case study: the SMARTPHONE

Its CONSTITUENTS

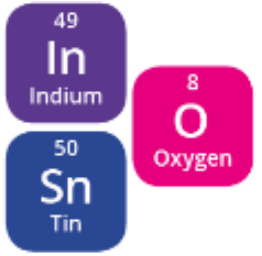


Source: Priorities for critical materials for a circular economy (EASAC)

The SCREEN



INDIUM TIN OXIDE is used in a transparent film that conducts electricity, allowing the screen to function as touch screen.



The glass used on majority of smartphones is an ALUMINOSILICATE glass (ALUMINA+SILICA). This glass can also contains POTASSIUM ions which help to strengthen it.

A variety of RARE EARTH ELEMENT COMPOUNDS are used in small quantities to produce the colours in the screen. Some others can be used to reduce UV light penetration into the phone.

Source: Priorities for critical materials for a circular economy (EASAC) & COMPOUND INTEREST 2014

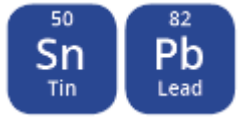
ELECTRONICS and BATTERY

COPPER is used for wiring in the phone; COPPER-GOLD-SILVER are the major metals from which microelectrical components are fashioned. TANTALUM is the major component of micro-capacitors.

NICKEL is used in the microphone and for electrical connections. ALLOYS including PRASEODYMIUM, GADOLINIUM and NEODYMIUM are used in magnets in the speaker and microphone. NEODYMIUM, TERBIUM and DYSPROSIUM are used in the vibration unit.

Pure SILICON is used to manufacture the chip in the phone. It is oxidised to produce non-conducting regions, then other elements are added to allow the chip co conduct electricity.

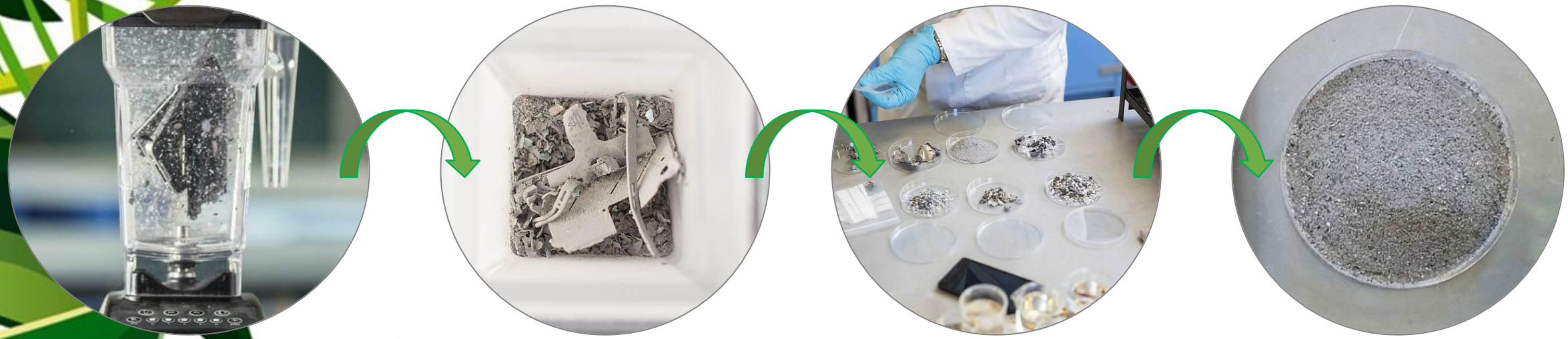
TIN and LEAD are used to solder electronics in the phone.



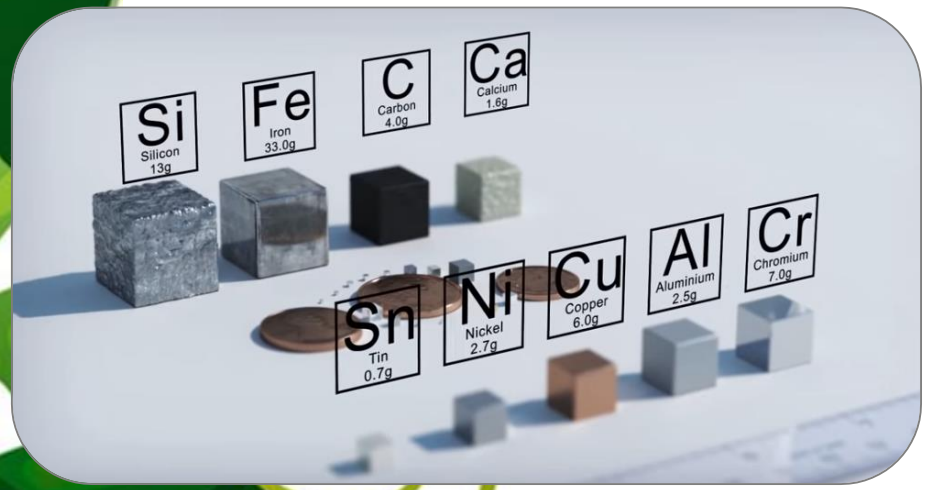
The majority of phones use LITHIUM ION batteries, which are composed of LITHIUM COBALT OXIDES as a positive electrode and GRAPHITE as the negative one. Some batteries use other metals, such as MANGANESE in place of cobalt. The battery's casing is made of ALUMINIUM.

Source: Priorities for critical materials for a circular economy (EASAC) & COMPOUND INTEREST 2014

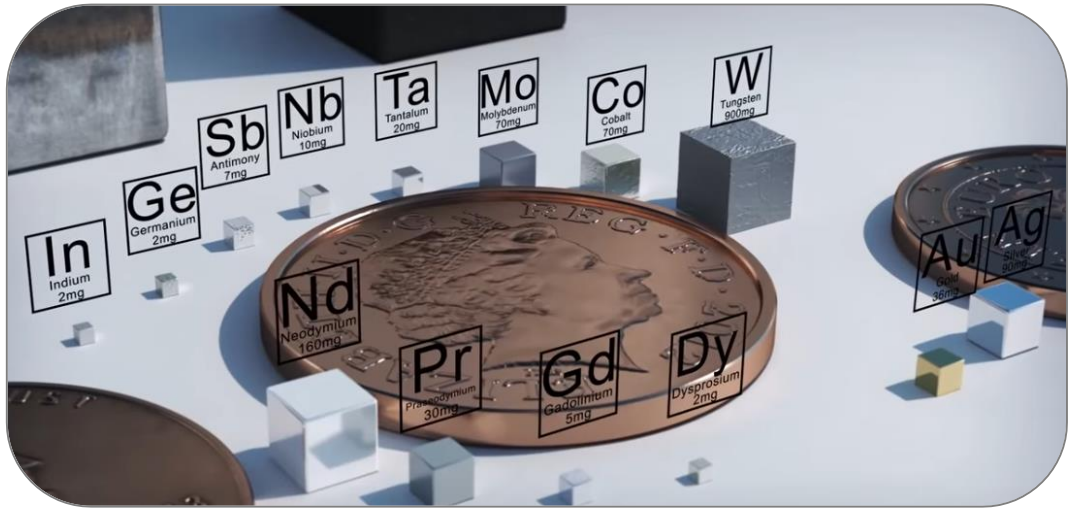
An EXPERIMENT @ Plymouth University



METALS CONTENT



RARE EARTH ELEMENTS CONTENT



Source: https://www.youtube.com/watch?v=bhuWmcDT05Q&feature=youtu.be

Thanks for your attention!

Nazarena Vincenti & Antonella Castellano
Projects Specialists

E-mails: vincenti@ecodom.it; castellano@ecodom.it