Good practices of metallurgy of copper

Module I: Waste Valorization in the copper metallurgy; implications in the circular economy

Part 1: Regulation and Circular Economy

- Juan Pedro Bolívar Raya (bolivar@uhu.es)
- Silvia Pérez Moreno (Silvia.perez@dci.uhu.es)
- **Center for Natural Resources, Ealth and Environment (RENSMA). University of Huelva.**

European Institute of Innovation & Technology

Funded by the European Union

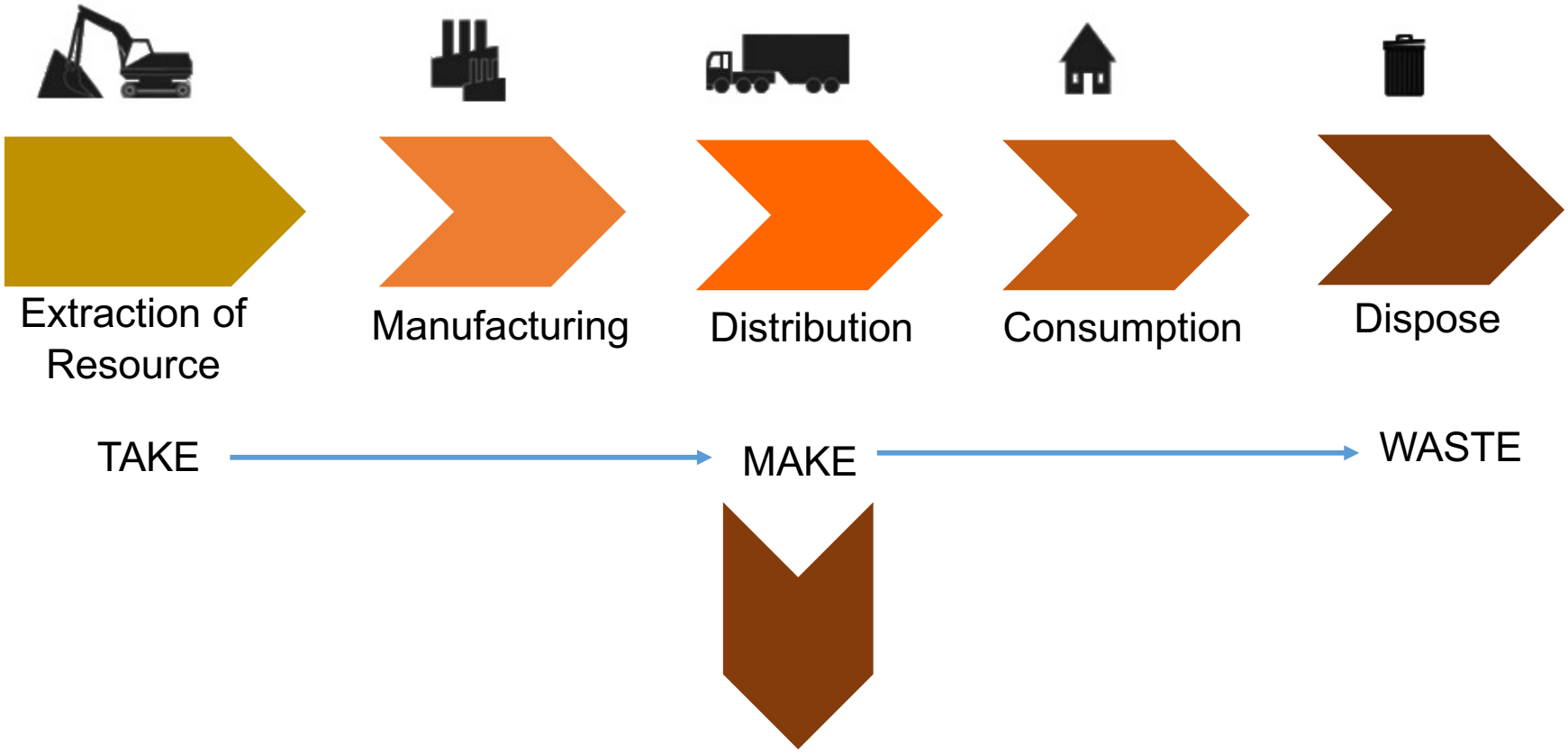
Highlights

1. Linear economy (LE) versus the circular economy (CE)
2. Keywords: Climate change, energy efficiency, renewable energy and the circular economy
3. European regulation on waste
4. Valorization, by-product and End of Waste (EoW)

European Institute of Innovation & Technology
Funded by the European Union
HEI4S3 RM

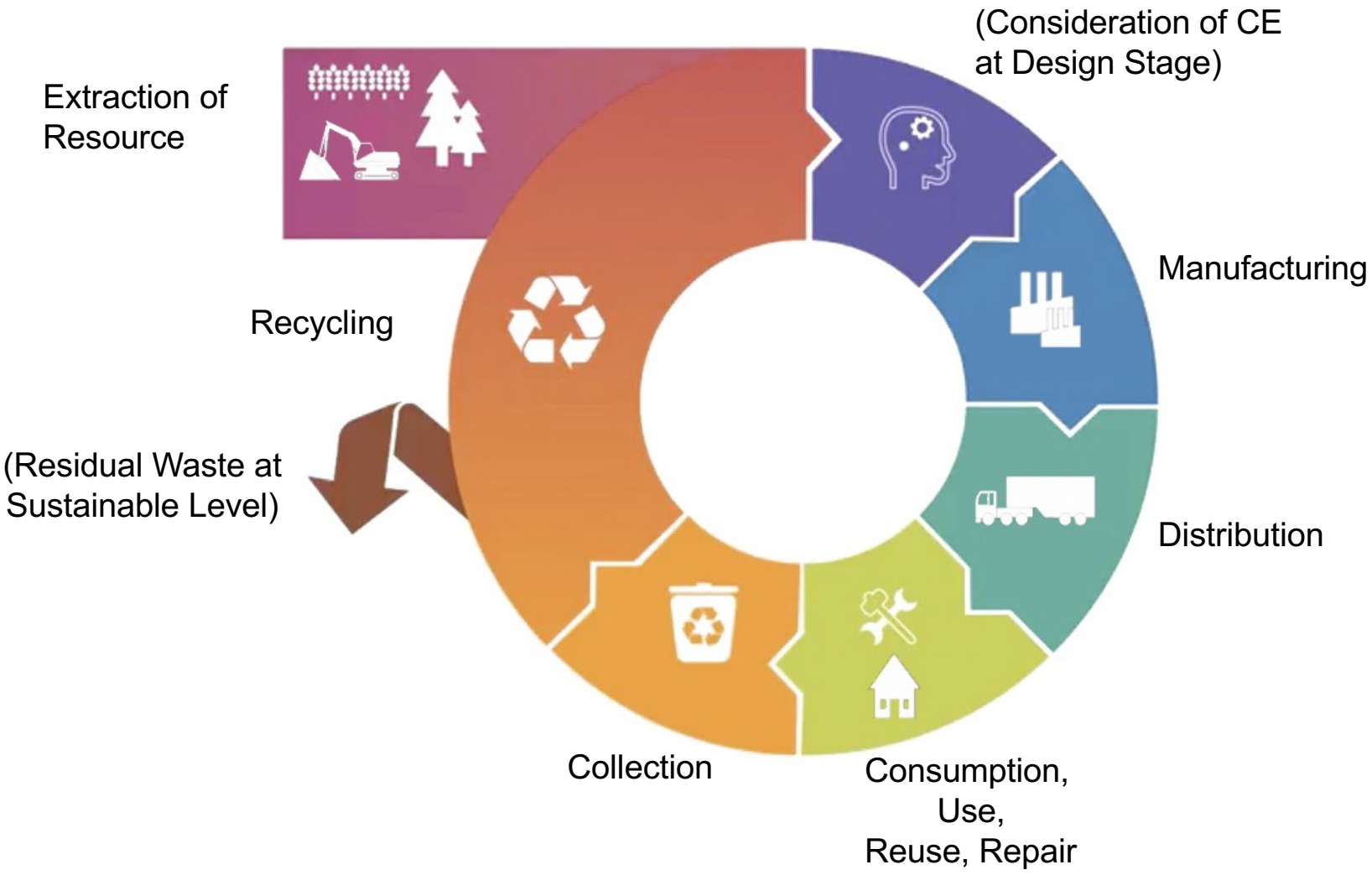
The Broad Concept … of Circular Economy

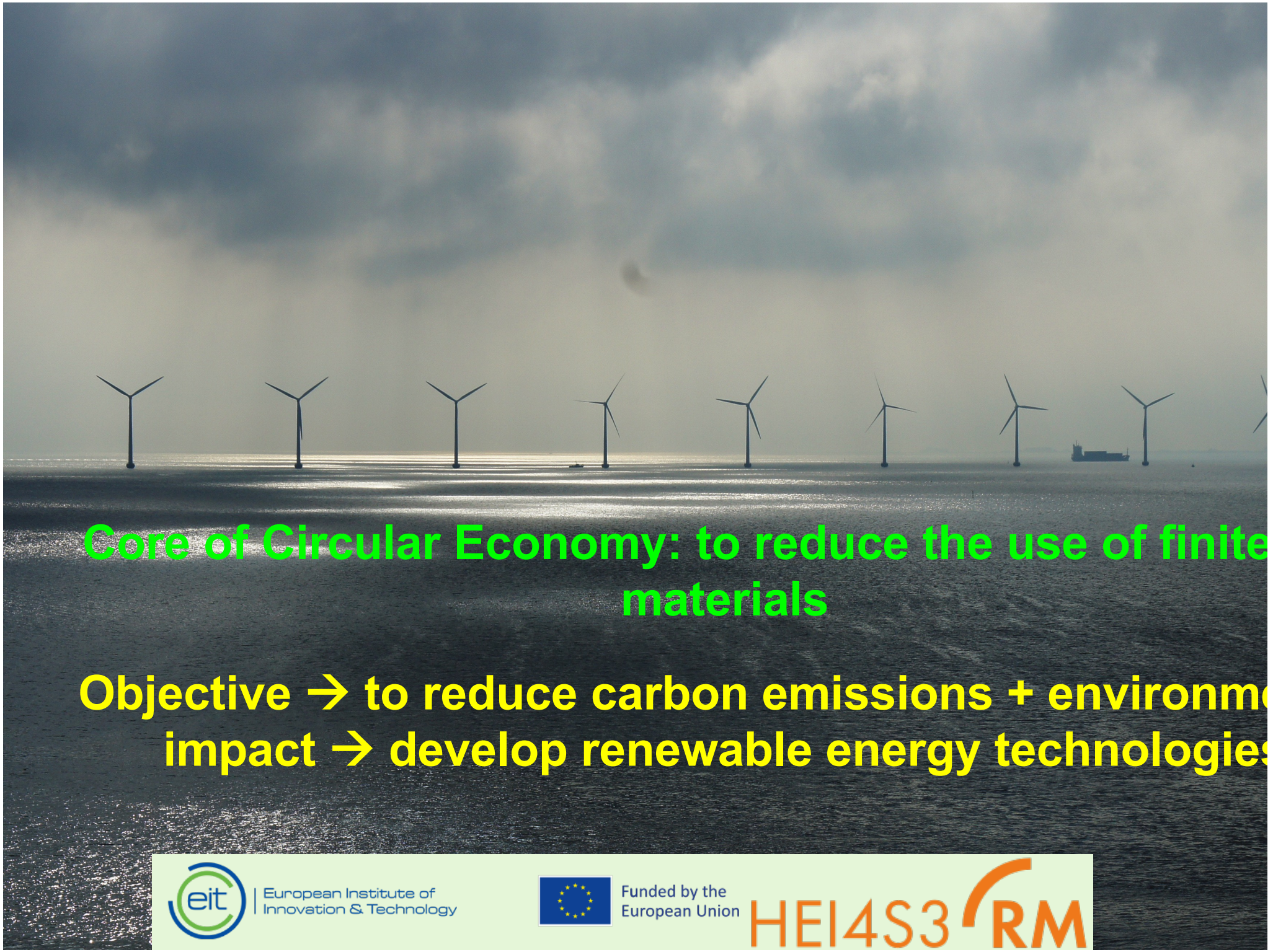
The Linear Economy



Depletion of Finite Natural Resources + Environmental impact →
Not sustainable model

The Circular Economy

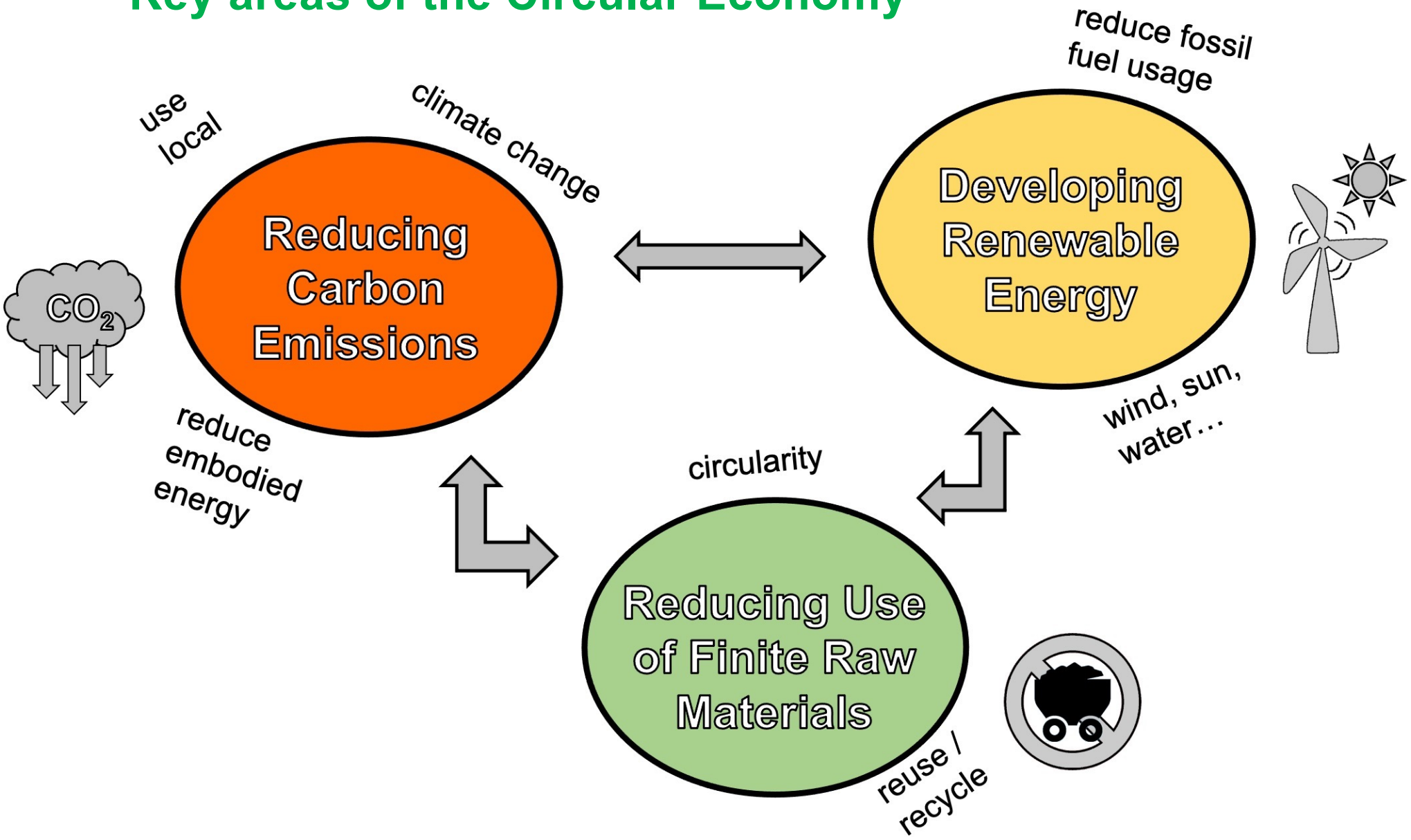



Core of Circular Economy: to reduce the use of finite materials
Objective → to reduce carbon emissions + environm
impact → develop renewable energy technologie
European Institute of Innovation & Technology
Funded by the European Union
HEI4S3 RM

The Broad Concept...

https://www.youtube.com/watch?v=zCRKvDyyHmI

Key areas of the Circular Economy



These broad targets **compliment** the principles of the Circular Economy concept

Further information: https://www.un.org/sustainabledevelopment/

For a cleaner and more competitive Europe

eit | European Institute of Innovation & Technology

Funded by the European Union

HEI4S3 RM

CIRCULAR ECONOMY ACTION PLAN (2022)

2. A SUSTAINABLE PRODUCT POLICY FRAMEWORK
- 2.1. Designing sustainable products
- 2.2. Empowering consumers and public buyers

3. KEY PRODUCT VALUE CHAINS
- 3.1. Electronics and ICT (Information and Comunication Technologies)
- 3.2. Batteries and vehicles
- 3.3. Packaging
- 3.4. Plastics
- 3.5. Textiles
- 3.6. Construction and buildings
- 3.7. Food, water and nutrients

4. LESS WASTE, MORE VALUE
- 4.1. Enhanced waste policy in support of waste prevention
- 4.2. Enhancing circularity in a toxic-free environment
- 4.3. Creating a well-functioning EU market for secondary raw materials
- 4.4. Improving the control of waste exports from the EU

5. MAKING CIRCULARITY WORK FOR PEOPLE, REGIONS AND CITIES

6. CROSSCUTTING ACTIONS
- 6.1. Circularity as a prerequisite for climate neutrality
- 6.2. Getting the economics right
- 6.3. **Driving the transition through research, innovation and digitalisation**

7. LEADING EFFORTS AT GLOBAL LEVEL

8. MONITORING PROGRESS

Sustainability principles to regulate the following aspects:

- improving product durability, reusability, upgradability and reparability, addressing the presence of hazardous chemicals in products, and increasing their energy and resource efficiency;
- increasing recycled content in products, while ensuring their performance and safety;
- enabling remanufacturing and high-quality recycling;
- reducing carbon and environmental footprints;
- restricting single-use, and avoid the planned obsolescence;

- Society must treat **waste as a resource**.
- **Urban mining** provide an abundance of secondary raw materials that can be recovered and recycled.
- To maximize the potential of the **urban mine** communities need to **develop an adequate local infrastructure**, and positive market conditions.
- The **copper industry** alongside committed partners can create a culture of responsibility, positive change and smart creation without waste.

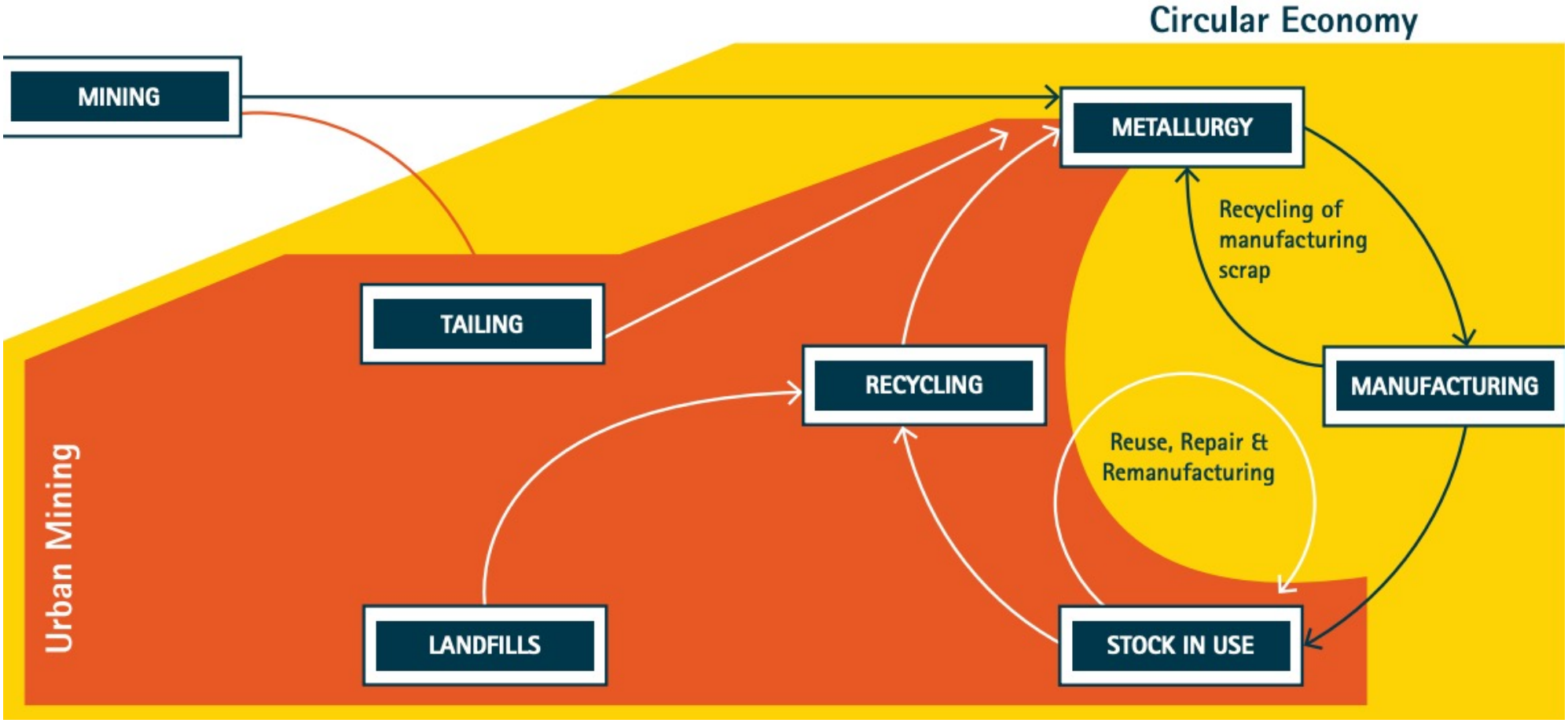
INVOLVED PARTIES:

- **PRODUCT DESIGNERS –** Product designers can design for sustainability to **facilitate recovery of metals** when the product is ultimately recycled.
- **SUPPLIERS AND MANUFACTURERS –** Suppliers and manufacturers must work together to establish close-loop **recycling streams of waste**, **as metal scraps** generated during manufacturing.
- **CONSUMERS –** Well-informed customers play a key role in assuring end-of-life products are collected for recycling, rather than sent to the landfill.
- **RECYCLERS –** Recyclers are investing in new technologies to recover many metals from complex copper products.

The Problem of Waste in Copper Manufacturing

The Copper Metallurgical Sector presents the biggest opportunity to reduce waste and move the economy in a 'Circular' direction

Urban mining is a part of the circular economy



European Institute of Innovation & Technology
Funded by the European Union
HEI4S3 RM

RELEVANT EUROPEAN REGULATION

Directive 2008/98/CE on waste and repealing certain Directives.

Commission Regulation (EU) No 1357/2014 replaces Annex III to Directive 2008/98/EC, defining the dangerous properties of the hazardous waste → 15 "HP" codes

The **EU's Circular Economy Action Plan** (CEAP) was a comprehensive body of legislative and non-legislative actions adopted in 2015, and they are updated periodically

Law 7/2022 (Spain) of waste and polluted soils into for a circular economy

WASTE DEFINITION

DIRECTIVE 2008/98/CE: "any substance or object of which its possessor disposes of, or has the intention, or obligation to dispose of"

When a material is considered an hazardous waste ?

A. European List of Waste (LoW)

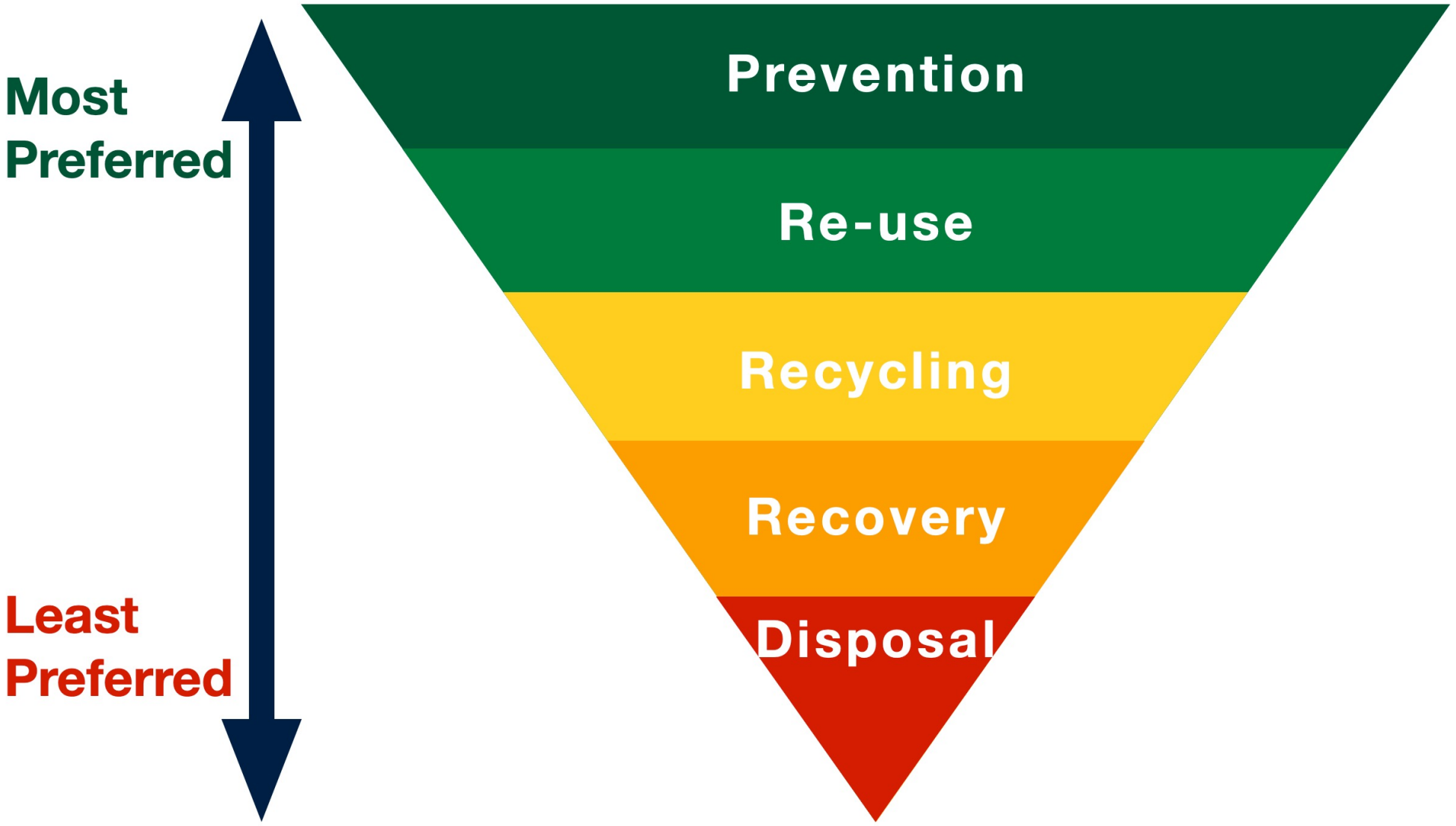
(*) = Hazardous waste

Without (*) = Non Hazardous waste

B. Commission Decision 2014/955/EU: 'Decision on the List of Waste' replacing Commission Decision 2000/532/EC of 3 May 20002

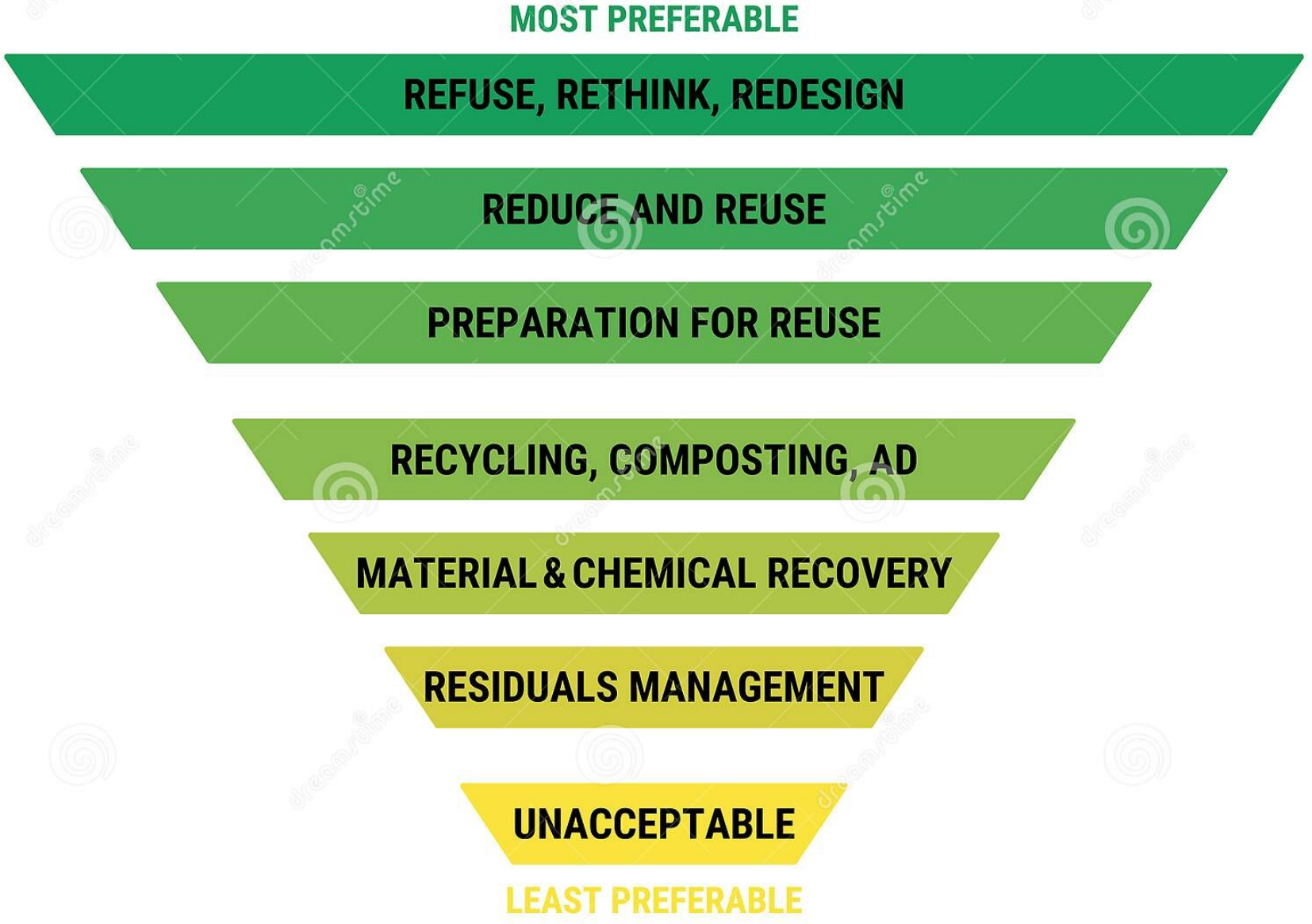
C. Waste Framework Directive (WFD) → HP codes (15 properties)

WASTE MANAGEMENT HIERARCHY



eit | European Institute of Innovation & Technology
Funded by the European Union
HEI4S3 RM

THE ZERO WASTE HIERARCHY



Hazardous waste Properties (Annex III of the FWD)

Pictogram	Physical hazard classes	Hazardous properties
	Unstable explosives	HP1 Explosive
	Explosives, divisions 1.1, 1.2, 1.3, 1.4	
	Self-reactive substances and mixtures, types A, B	
	Organic peroxides, types A, B	
	Oxidizing gases, category 1	HP 2 Oxidising
	Oxidizing liquids, categories 1, 2, 3	
	Oxidizing solids, categories 1, 2,	
	Flammable gases, category 1	HP 3 Flammable
	Flammable aerosols, categories 1, 2	
	Flammable liquids, categories 1, 2, 3	
	Flammable solids, categories 1, 2	
	Self-reactive substances and mixtures, types B, C, D, E, F	
	Pyrophoric liquids, category 1	
	Pyrophoric solids, category 1	
	Self-heating substances and mixtures, categories 1, 2	
	Substances and mixtures, which in contact with water, emit flammable gases, categories 1, 2, 3	
	Organic peroxides, types B, C, D, E, F	
No pictogram	Explosive, division 1.5	HP 15
	Explosive, division 1.6	Not applicable
	Flammable gas, category 2	HP 3 Flammable
	Self-reactive substances and mixtures, type G	Not applicable
	Organic peroxides, type G	Not applicable

Pictogram	Human health hazard classes	Hazardous properties
	Skin corrosion, category 1A	HP 4 Irritant HP 8 Corrosive
	Skin corrosion, categories 1B and 1C	HP 8 Corrosive
	Serious eye damage, category 1	HP 4 Irritant
	Corrosive to metals	Not applicable
	Acute toxicity (oral, dermal, inhalation), categories 1, 2, 3	HP 6 Acute Toxicity
	Respiratory sensitization, category 1	HP 13 Sensitising
	Germ cell mutagenicity, categories 1A, 1B, 2	HP 11 Mutagenic
	Carcinogenicity, categories 1A, 1B, 2	HP 7 Carcinogenic
	Reproductive toxicity, categories 1A, 1B, 2	HP 10 Toxic for reproduction
	Specific target organ toxicity following single exposure, categories 1, 2	HP 5 Specific Target Organ Toxicity / Aspiration Toxicity
	Specific target organ toxicity following repeated exposure, categories 1, 2	
	Aspiration hazard, categories 1, 2	
	Acute toxicity (oral, dermal, inhalation), category 4	HP 6 Acute Toxicity
	Skin irritation, categories 2, 3	HP 4 Irritant
	Eye irritation, category 2	
	Skin sensitization, category 1	HP 13 Sensitising
	Specific target organ toxicity following single exposure, cat. 3 • Respiratory tract irritation • Narcotic effects	HP 5 Specific Target Organ Toxicity / Aspiration Toxicity
No pictogram	Acute toxicity (oral, dermal, inhalation), category 5	Not applicable
	Reproductive toxicity – effects on or via lactation	Not applicable
Not subject to chemical labelling requirements	Not applicable	HP 9 Infectious

Valorization, by-product and end of waste (EoW)

By-product Status
(Art. 5 Waste Framework Directive, WFD)

A substance or object that **verifies the conditions**:

a) **further use** of the substance or object is **certain**;

b) the substance or object can be **used directly without any further processing** other than normal industrial practice;

c) the substance or object is produced as an **integral part of a production process**; and

d) **further use is lawful**, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and **will not lead to overall adverse environmental or human health impacts**.

eit | European Institute of Innovation & Technology
Funded by the European Union
HEI4S3 RM

End of Waste Status

(Art. 6. Waste Framework Directive, WFD)

The waste shall cease to be waste verifying the following conditions:

a) the substance or object is commonly used for **specific purposes**;

b) a market or demand exists for such a substance or object;

c) the substance or object **fulfils the technical requirements** for the specific purposes and meets the existing legislation and standards applicable to products; and

d) the use of the substance or object **will not lead to overall adverse environmental or human health impacts**.

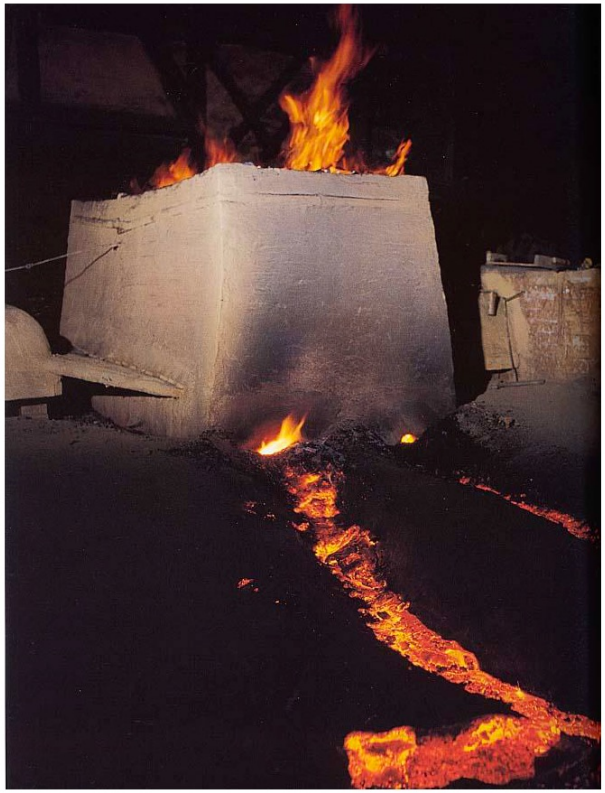
The **criteria** shall include **limit values for pollutants** where necessary and shall take into account any possible adverse environmental effects of the substance or object.

eit | European Institute of Innovation & Technology

Funded by the European Union

HEI4S3 RM

An example: slags from electric furnage as a by-produc



Historical Situation: slags storing

eit | European Institute of Innovation & Technology

Funded by the European Union

HEI4S3 RM

Table 1. Chemical compositions of cement and copper slag
(Khanzadi and Behnood, 2009; Meenakshi and Illagovan, 2011)

Component		**CS (%)** (Khanzadi and Behnood, 2009)	**CS (%)** (Meenakshi and Illagovan, 2011)
Silica	(SiO_2)	33.05	27
Aluminium oxide	(Al_2O_3)	2.79	<3
Iron oxide	(Fe_2O_3)	53.45	55
Calcium oxide	(CaO)	6.06	-
Magnesium oxide	(MgO)	1.56	-
Sulphur trioxide	(SO_3)	1.89	0.2
Potassium oxide	(K_2O)	0.61	-
Sodium oxide	(Na_2O)	0.28	-
Manganese trioxide	(Mn_2O_3)	0.06	-
Copper oxide	(CuO)	0.46	<1
Ignition loss		0	-

Fe,….Mo

Cu,….Au, Ag

CaO, SiO_2, Al_2O_3

Utilization for cement

Effective utilization of copper slag

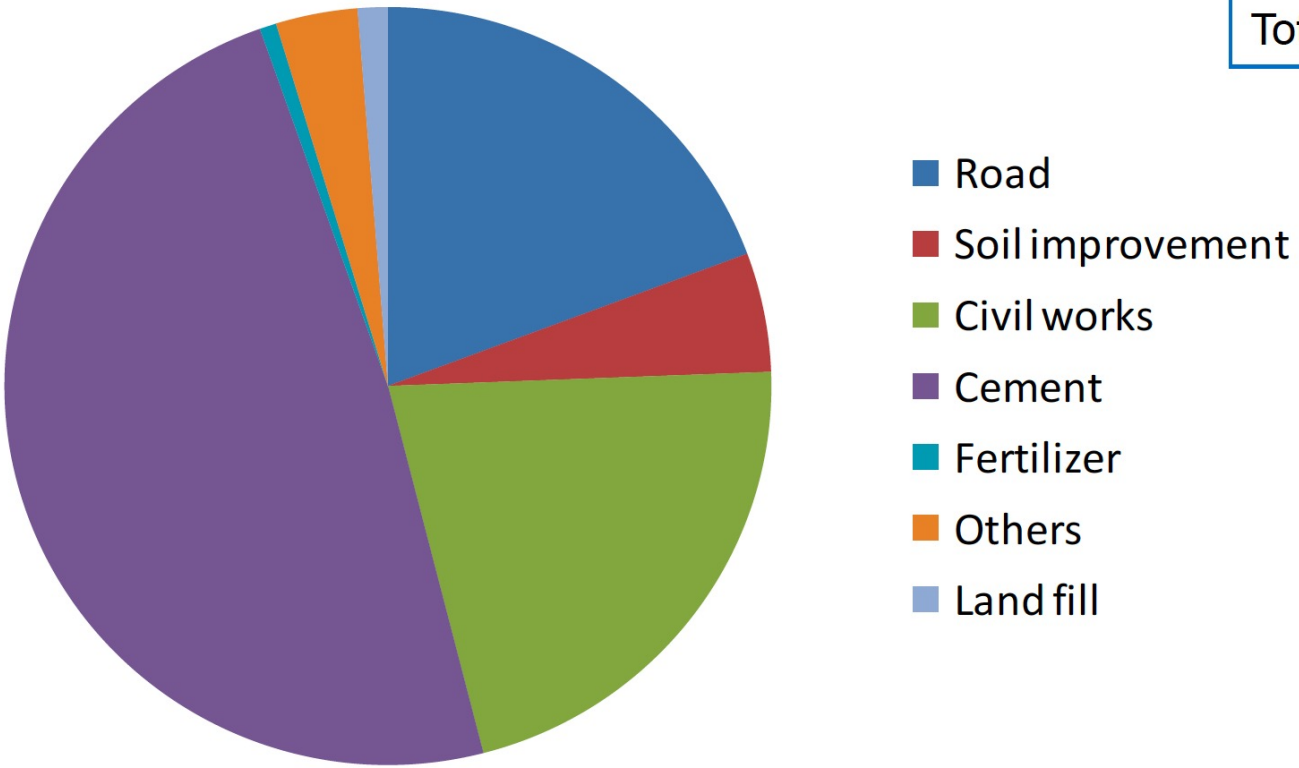
European Institute of Innovation & Technology

Funded by the European Union

HEI4S3 RM

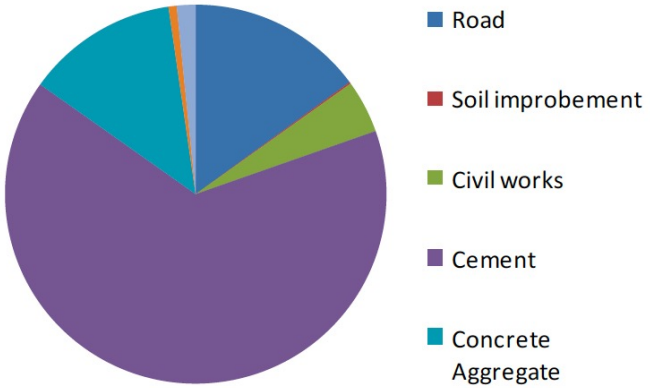
Slag Utilization

Uses of Slag in Japan(2007)



Total production	40939000 t
Total Uses	41868000 t

Uses of BF Slag in Japan (2007)



European Institute of Innovation & Technology
Funded by the European Union
HEI4S3 RM

Funded by the
European Union

HEI4S3 RM

THANKS FOR YOUR ATTENTION