



Italian National Agency for New Technologies,
Energy and Sustainable Economic Development

The InnoWEEE project and the ReSiELP project: two successful examples of technological solutions in support of The Circular Economy

Portici, 28th October 2020

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**Head of Laboratory Technologies for the Reuse, Recycling, Recovery and
valorisation of Waste and Materials (T4RM)**



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ENEA – About us

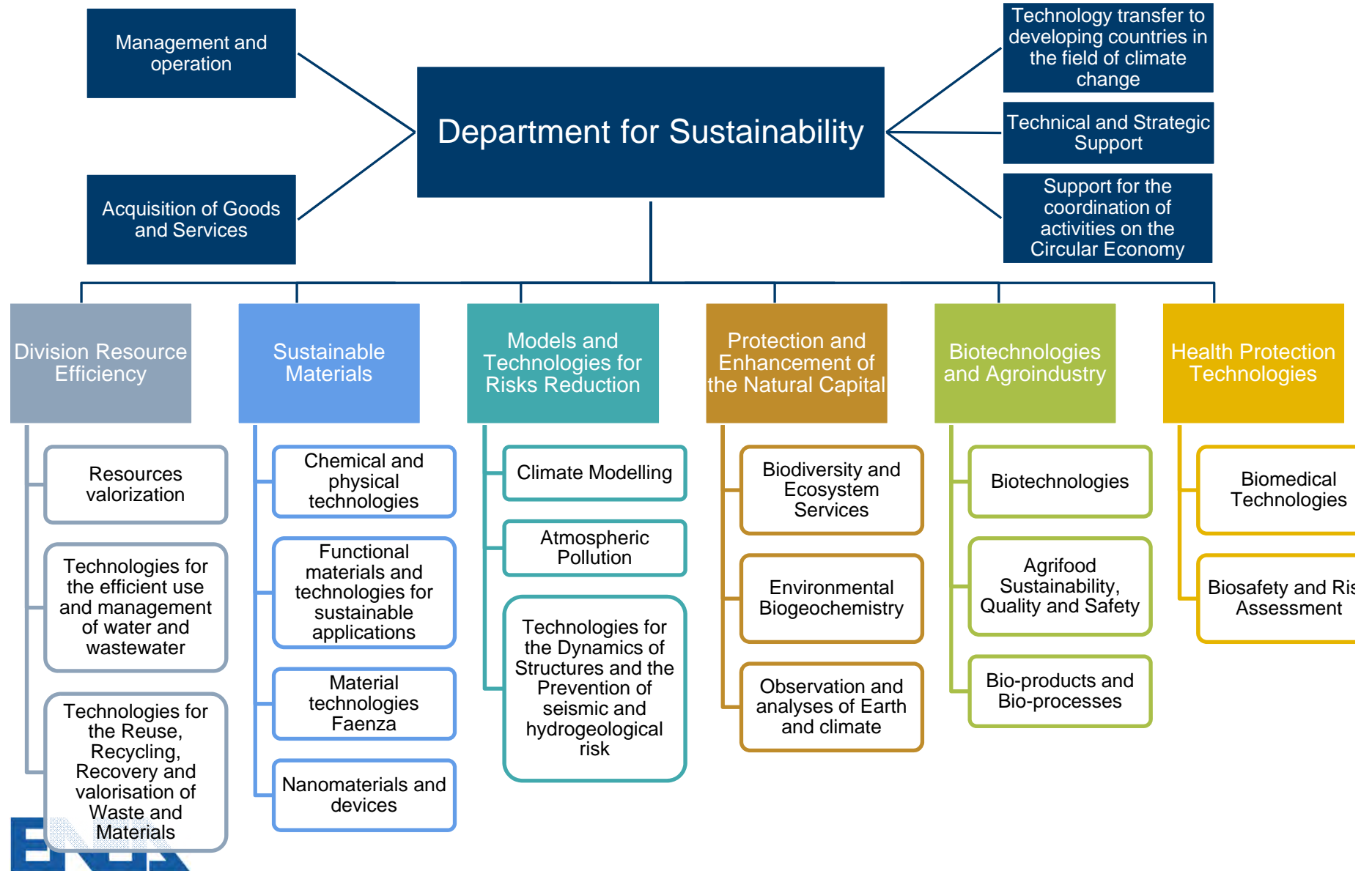


Created in 1960, ENEA is the National Agency for New Technologies, Energy and Sustainable Economic Development, a public body aimed at research, technological innovation and the provision of advanced services to enterprises, PA

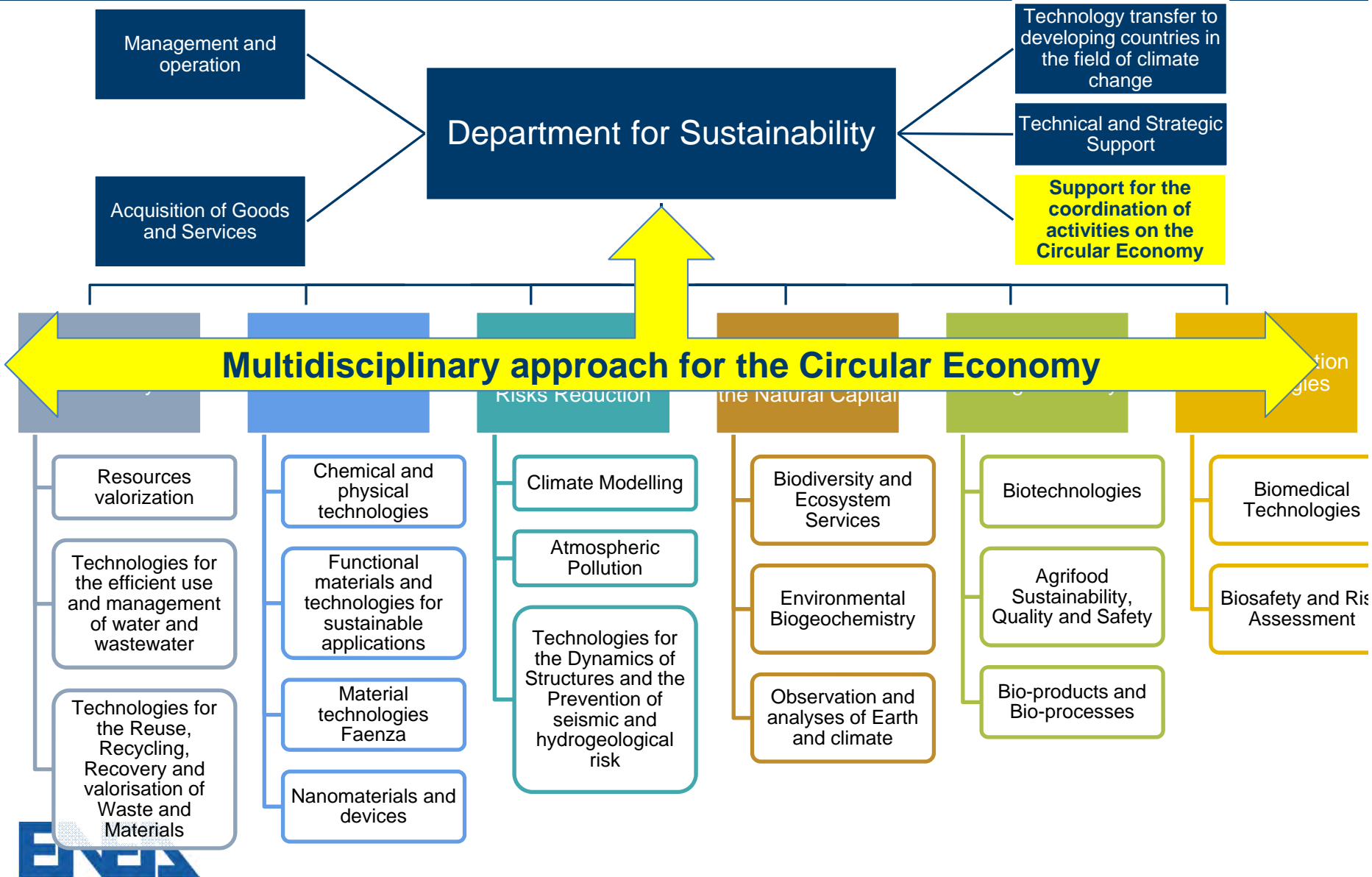
- More than **2,500 people**
- **13 research centres** in Italy
- **4 Departments**
 - Energy Technologies
 - Energy Efficiency Unit Department
 - Fusion and Technology for Nuclear Safety and Security
 - ***Territorial and Production Systems Sustainability***



Department for Sustainability - SSPT



Department for Sustainability - SSPT

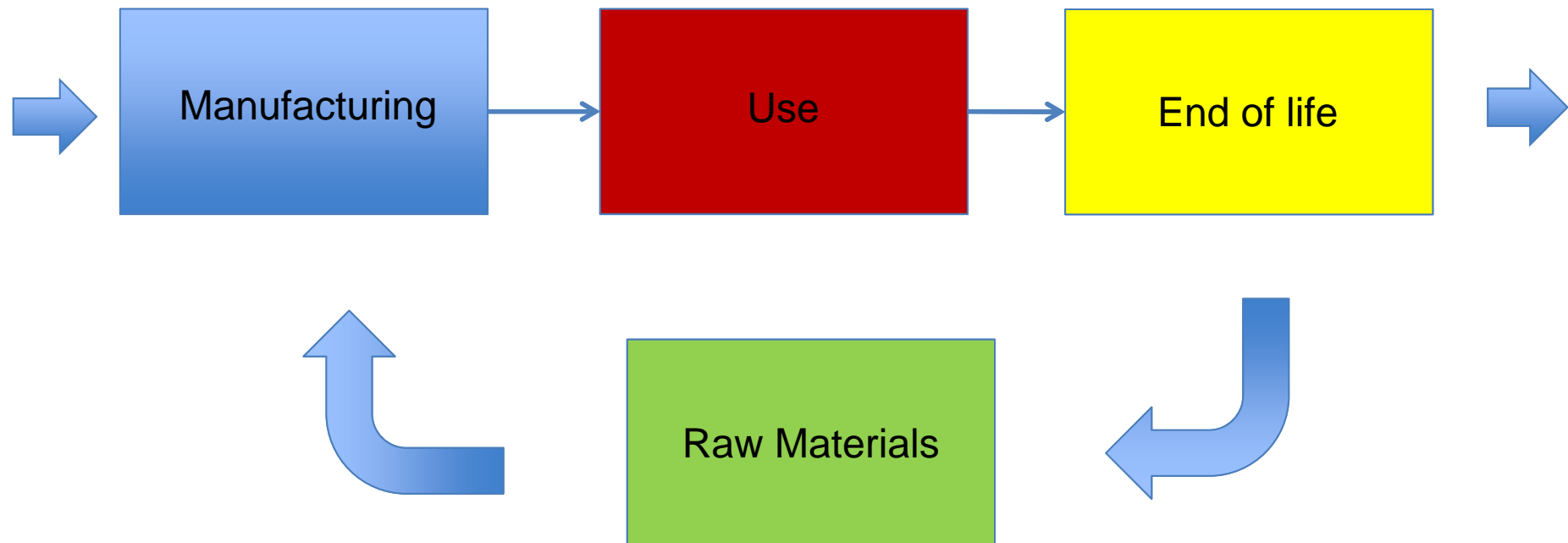


Department for Sustainability - SSPT

- **Activities in many sectors of research**
- **Promote the Circular Economy**
- **Environmental impacts**

Waste management: treatment, recycling, materials recovery, reuse.

Circular vs Linear



Circular Economy

In the “circular economy” model products maintain their added value for as long as possible with a "zero waste“ objective.

For the transition we need:

- Increasing efficiency in the use of resources and a minimization of waste production.
- Eco-innovation in production cycles (more sustainable technologies, new materials, recycling chains).
- Development of new sustainable treatments of wastes in order to recovery all materials as possible.
- Formation and information for citizens.



ENEA for circular economy

Product Eco-Innovation

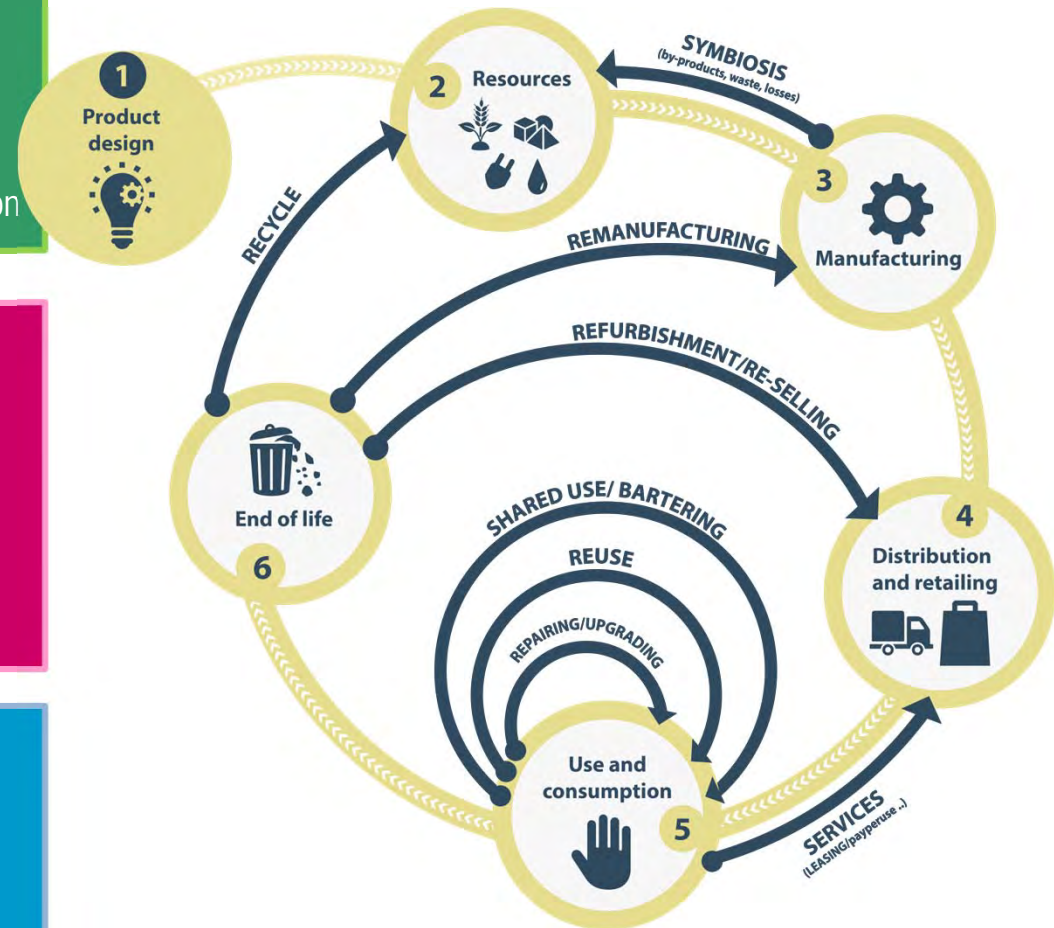
- Eco-design
- Life Cycle Thinking (LCT, LCA,..)
- Recyclability, durability, easy disassembly
- Raw Materials: nanomaterials, biomaterial, recycled materials, critical and hazardous raw materials substitution

Process Eco-Innovation

- Low resource consumption
- Low energy consumption
- Low emissions
- Clean technologies
- Lean technologies

System Eco-Innovation

- Industrial symbiosis
- Sharing economy (Remanufacturing, second hand products, from goods posses to services)
- Waste management
- Urban mining/landfill mining
- Reuse/Remanufacture/Recycling



Circular economy: Integrated approaches



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#CEstakeholderEU

European Circular Economy Stakeholder Platform

A joint initiative by the European Commission and the European Economic and Social Committee



ECESP tasks:

- ✓ promote the dissemination of knowledge
- ✓ foster dialogue and identification of possible synergies
- ✓ map good circular economy practices

Partner



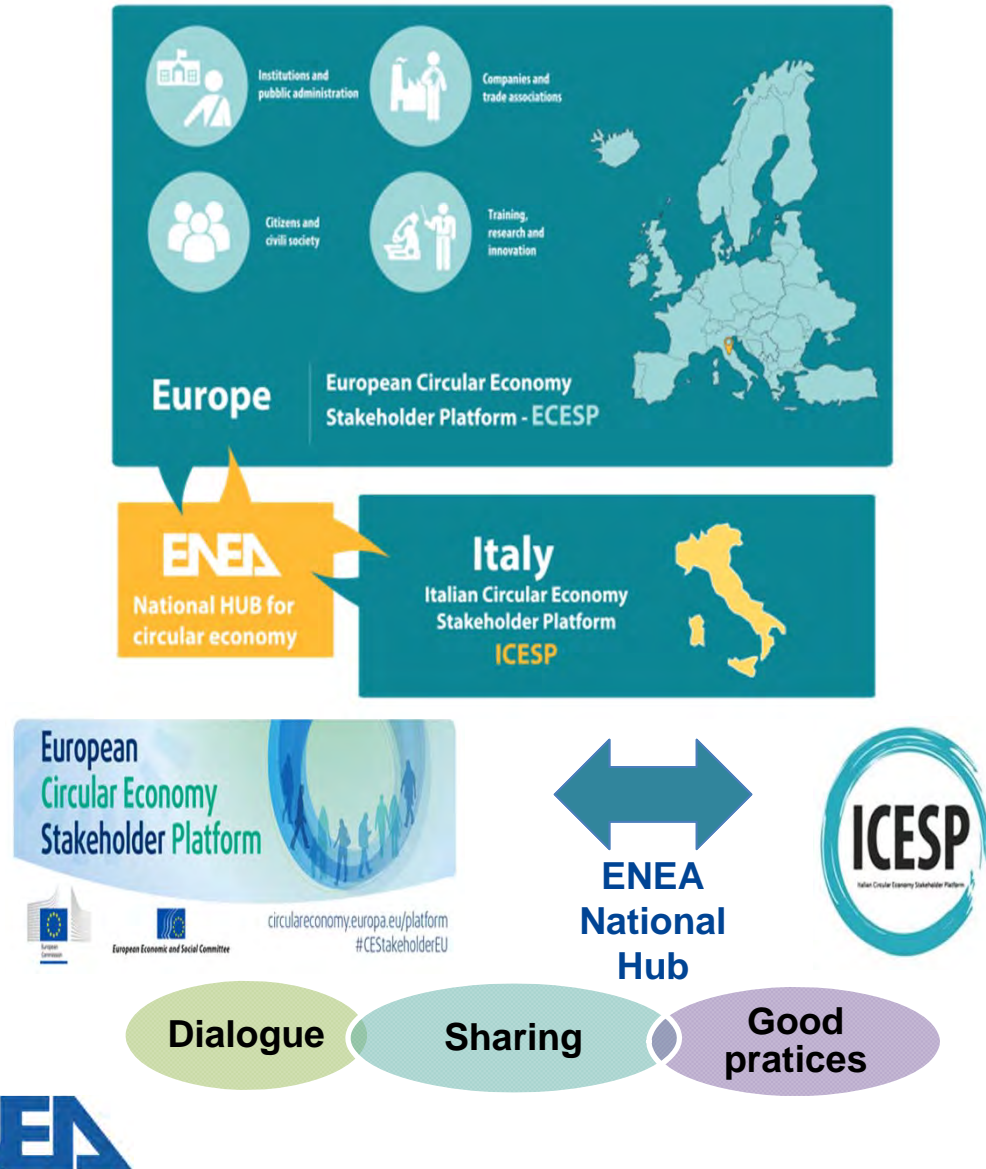
www.icesp.it

Italian Circular Economy Stakeholder Platform

- ✓ Italian «mirror» platform
- ✓ 52 members
 - ✓ Institutions (18%)
 - ✓ Firms & Associations (57%)
 - ✓ Universities & Research (22%)
 - ✓ Citizens (3%)
- ✓ More than 100 participants in the 6 working groups



Italian Circular Economy Platform - ICESP



The **Italian Circular Economy Platform (ICESP)**, promoted and coordinated by ENEA, was born in May 2018 as **ECESP mirror**, after selection of ENEA in ECESP Coordination Group.

The main ICESP objective is reinforce the role of Italy in promotion, implementation and dissemination of circular strategy, enhancing the Italian weight in international community.

ICESP – Organization and structure

✓ Coordination

Chair: *Roberto Morabito*

Italian member of ECESP Coordination group: *Laura Cutaia*

Technical coordinator: *Grazia Barberio*

✓ Committee of coordinators of working groups

✓ Members (94 organizations)

✓ Working group participants (members and external experts) (176 organizations)

✓ Best practices revision committee



ICESP – Objectives and instruments



Purposes

- ✓ promote the knowledge diffusion;
- ✓ favor initiatives integration at the Italian level;
- ✓ Mapping the Italian best practices;
- ✓ overcome the fragmentation of Italian initiatives;
- ✓ create a permanent operational tool that can facilitate **inter-sectorial dialogue and interactions**;
- ✓ promote Italian excellence and the Italian way for making circular economy, starting from the tradition and typicality of our country and its cultural, social and business models: "**The Italian way for circular economy**"



Relevant themes




- ✓ eco-innovation, research, development and technology transfer;
- ✓ regulatory, financial and market instruments;
- ✓ enterprises and supply chains organizational models;
- ✓ measurement tools and indicators;
- ✓ guidance and support to businesses;
- ✓ promotion of new cultural approaches and lifestyles;
- ✓ role of territories and cities in guiding the transition from global to local and vice-versa.



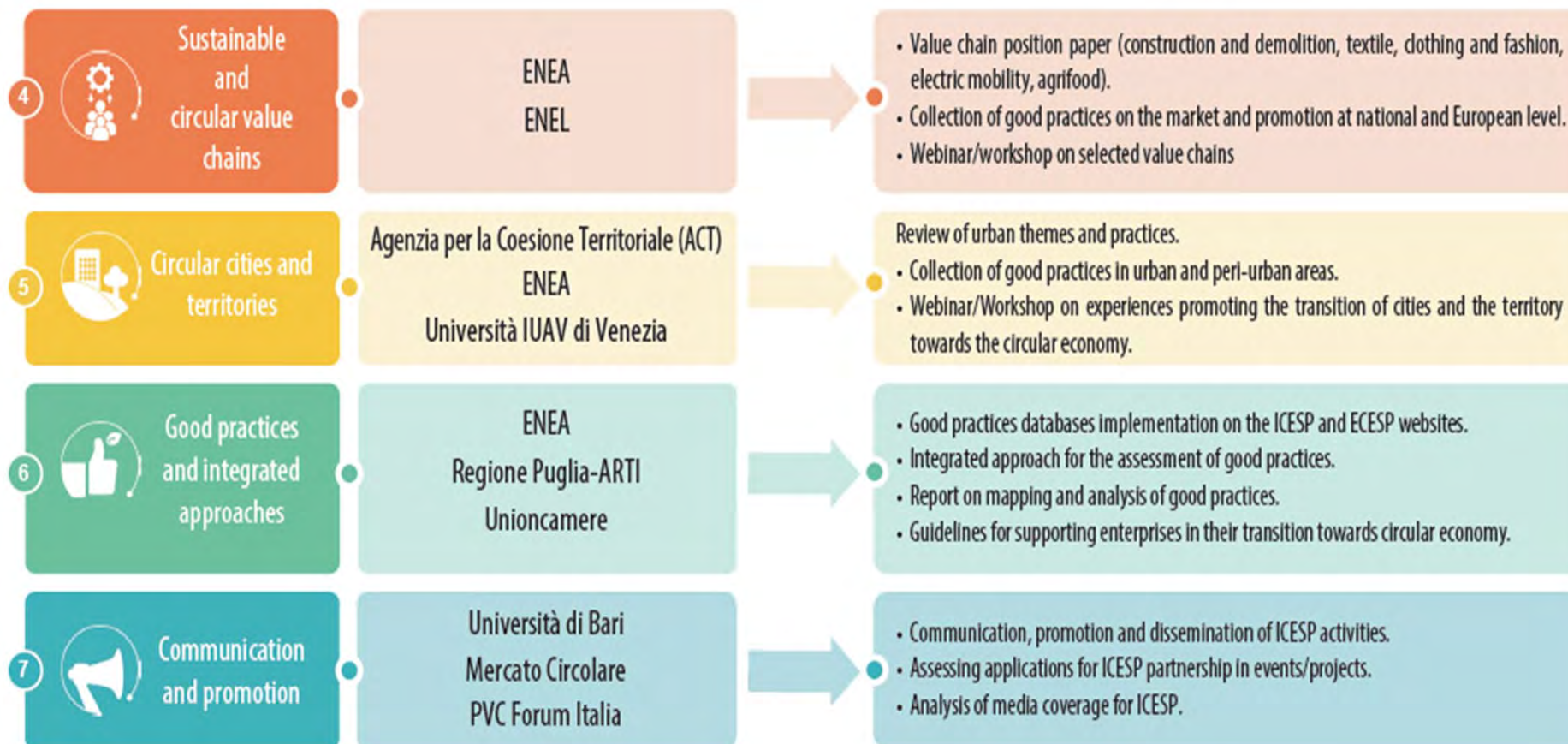
Instruments

- ✓ a web platform, to facilitate exchange of information and best practices <http://www.icesp.it>;
- ✓ support for the participation of the ECESP Coordination Group through the activities of the ICESP Working Groups;
- ✓ organization of events dedicated to communication and dissemination

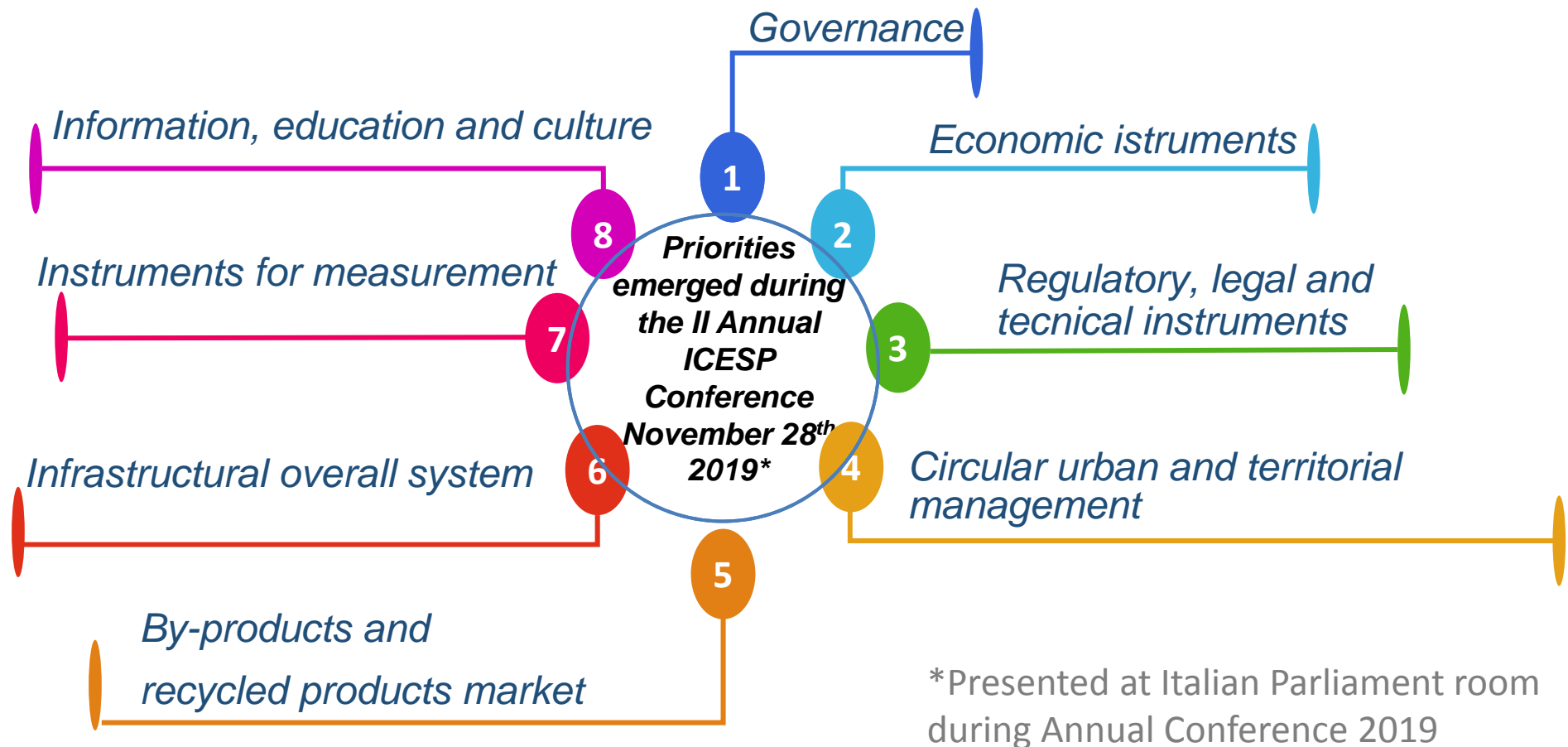
ICESP Working Groups

Name of Working Groups	Coordinators	Products foreseen from the Working Groups
<p>1  Research and eco-innovation, dissemination of knowledge and training</p>	<p>Confederazione Nazionale dell'Artigianato e della Piccola e Media Impresa Regione Puglia-ARTI Università di Bologna</p>	<p>Reports on the following activities of the sub-groups:</p> <ul style="list-style-type: none"> • Training and Skills → analysis of demand for skills and training supply side regarding eco-innovation, policy recommendations and system of technical training for companies. • Eco-innovation → Questionnaire looking into the dynamics of eco-innovation in companies, focussing on specific value chains (e.g. plastic, textiles) and the related policy recommendations for enterprises support tools.
<p>2  Policy and governance instruments</p>	<p>Ministero dell'Ambiente e della Tutela del Territorio e del Mare (MATTM) Ministero dello Sviluppo Economico (MISE) FISE UNICIRCULAR</p>	<ul style="list-style-type: none"> • Workshop, in collaboration with ISPRA (the Italian governmental environmental body), concerning application of End of Waste guidelines for companies. • Updating report on Policy and governance instruments. • Promotion and diffusion of governance instruments. • Collecting and assessing proposals together with stakeholders.
<p>3  Circular Economy Monitoring Tools</p>	<p>ENEA Comune di Pesaro Radici Group</p>	<ul style="list-style-type: none"> • Questionnaire for companies and public administrations. • Update of the previous report, with particular reference to Italian initiatives at micro level. • Uploading of the data sheets relating to the various measuring initiatives of the circular economy on the ICESP website.

ICESP Working Groups



Towards the Italian Agenda for Circular Economy: the ICESP priorities



The transition towards an Circular Economy model involves not only technical aspects



CICERONE is developing the strategic coordination of objectives and programming of regional, national and European funding programmes

CICERONE was designed and is being implemented by 24 partners from a variety of organisations across Europe - thus providing a well-rounded, holistic pathway to advance the EU's switch to a circular economy

CHALLENGE	ADRESSED TOPICS
Cities	Waste prevention and management / Urban water management and reuse / Urban mining / Sharing economy / Prolongation of products life - products reuse / Building / Food waste prevention and valorisation / Citizen awareness / Industrial systems
Industry	Eco-design / Product and process eco-innovation / Water cycle / Agroindustry / Metallurgy / Manufacturing / Lean and clean technologies / Chemicals / Industrial Symbiosis / Business models
Value Chains	Eco-design and Product eco-innovation / Value chain traceability / Sustainable consumption / Reuse / Collection / Recycling / Sharing economy
Territory & Sea	Marine litter / Material flows / Landfill mining / Sustainable tourism

ATELIER – Attività Tecniche e formative per lo sviluppo dell'Imprenditoria sull'Economia circolare



The project is part of the actions for the promotion of the circular economy (EC) in the Lombardy region and includes:

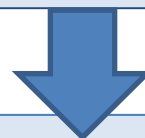
I. Territorial analysis with focus groups to identify training needs

II. Training of CCIAA staff (1 event) on topics such as EC principles, EC funding sources, industrial symbiosis for closing cycles

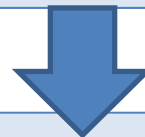
III. Business training (9 seminars in Lombardy) with tailor-made courses created ad hoc based on the needs identified in phase I.



OBJECTIVE MEDIUM-LONG TERM: REACHING THE NATIONAL SELF-SUFFICIENCY IN PHOSPHOROUS



Agreement with Italian Minister of Environment



ENEA is coordinating the Italian Platform for Phosphorous

Critical Raw Materials (CRM)

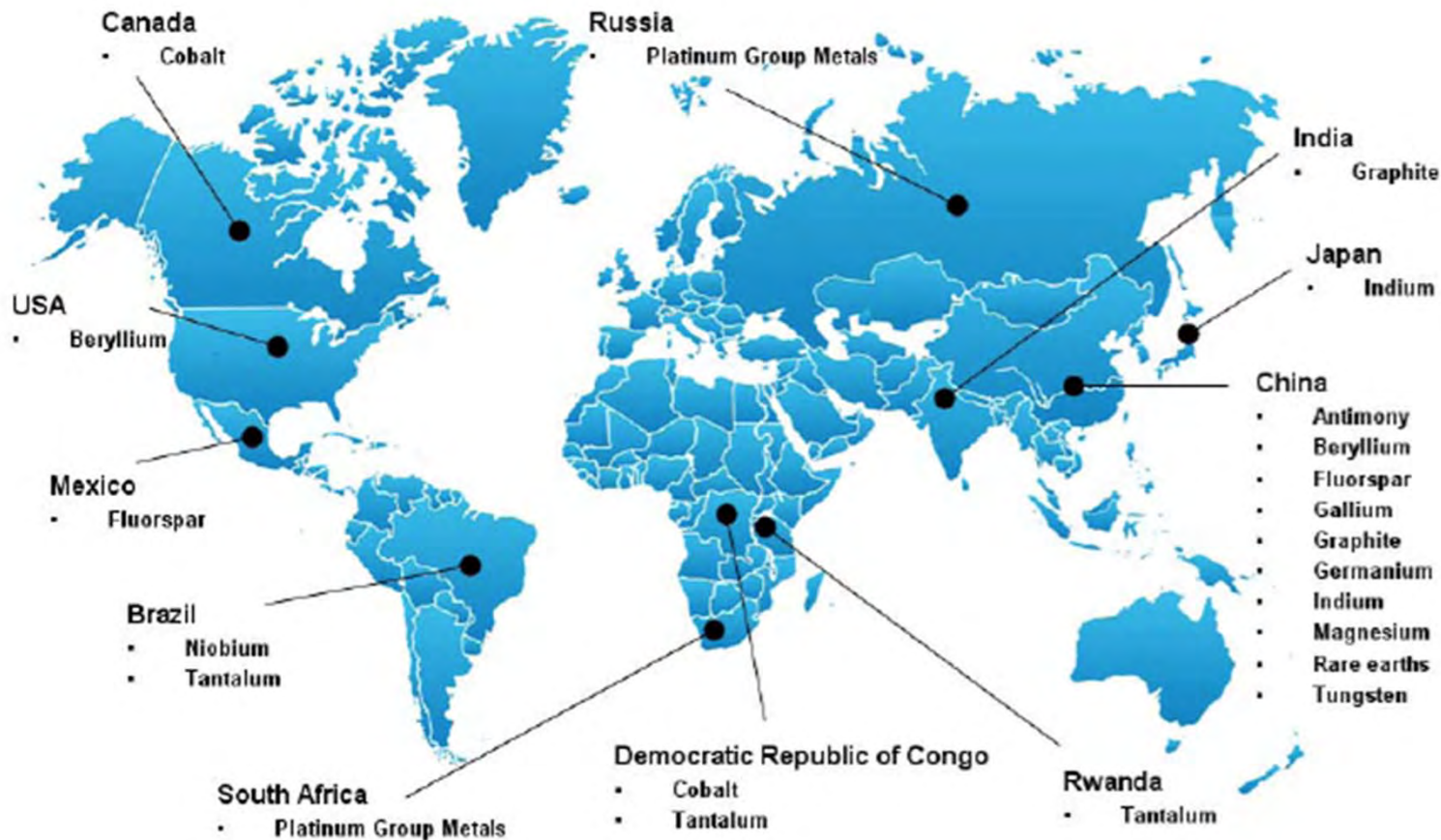
2020 critical raw materials (new as compared to 2017 in bold)		
Antimony	Hafnium	Phosphorus
Baryte	Heavy Rare Earth Elements	Scandium
Beryllium	Light Rare Earth Elements	Silicon metal
Bismuth	Indium	Tantalum
Borate	Magnesium	Tungsten
Cobalt	Natural graphite	Vanadium
Coking coal	Natural rubber	Bauxite
Fluorspar	Niobium	Lithium
Gallium	Platinum Group Metals	Titanium
Germanium	Phosphate rock	Strontium

Lista delle materie prime critiche individuate dalla Commissione Europea nel 2020

Secondo i dati della Commissione Europea, il rate di riciclo da prodotti a fine vita è ridotto, pari al 28% per l'antimonio, al 17% per i fosfati di roccia, 9% per il magnesio, 42% per il tungsteno, 44% per il vanadio, 14% per il platino, 8% per le terre rare leggere. Tuttavia è zero o pari a zero, per berillio, borati, cobalto, carbone da coke, gallio, indio, niobio, fosforo, silicio; solo l'1% per tantalio, barite, bismuto, fluorite, hafnio, elio e gomma naturale.

Critical Raw Materials (CRM)

Concentrazione della produzione mondiale di Materie prime critiche



Circular Economy: Methodologies



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Network of Infrastructures - PCRec

Network of European organizations in the recycling sector dedicated to the product centric recycling of WEEE:

- printed circuit boards
- LCD flat screens
- illumination devices
- permanent magnets



Integrated recycling technologies and services on: chracterization, pre-treatment, raw materials recycling and refining, sustainability evaluation, business plan



Industrial symbiosis

Industrial symbiosis is a strategy aiming at the efficient and optimal use of resources (materials, energy, water, expertise, etc.) among companies. Mutual benefits and competitive advantages arise for companies implementing industrial symbiosis

"...There are relationships between industries, sometimes simple, but often quite complex, which enter into and complicate the analysis. Chief among these is the phenomenon of industrial symbiosis. By this is meant the consorting together of two or more of dissimilar industries. ...".

Renner, Renner, G.T. Geography of Industrial Localization. Economic Geography 23, no. 3: 167-189., 1947

"Industrial symbiosis engages traditionally separate industries and other organisations in a network to foster innovative strategies for more sustainable resource use (including materials, energy, water, assets, expertise, logistics etc.)....."

Lombardi & Laybourn, NISP

In Italy over 180 million tons of waste/year are produced, 80% of these are not dangerous industrial waste

Industrial symbiosis

Economic benefits

1. Reduced costs for raw materials supply and for waste disposal and management
2. New business network
3. New market opportunities

Environmental benefits

1. Optimisation of resources use
2. Mitigation of environmental impacts and emissions
3. Reduction of the quantity of waste landfilled

Social benefits

1. Job (so called «green jobs»)
2. Cultural shift (sharing economy)

ENEA's methodology for industrial symbiosis

The ENEA methodology is based on a «horizontal» approach (network), aiming at closing the loop creating synergies for resource sharing



Language of symbiosis

Communication to companies



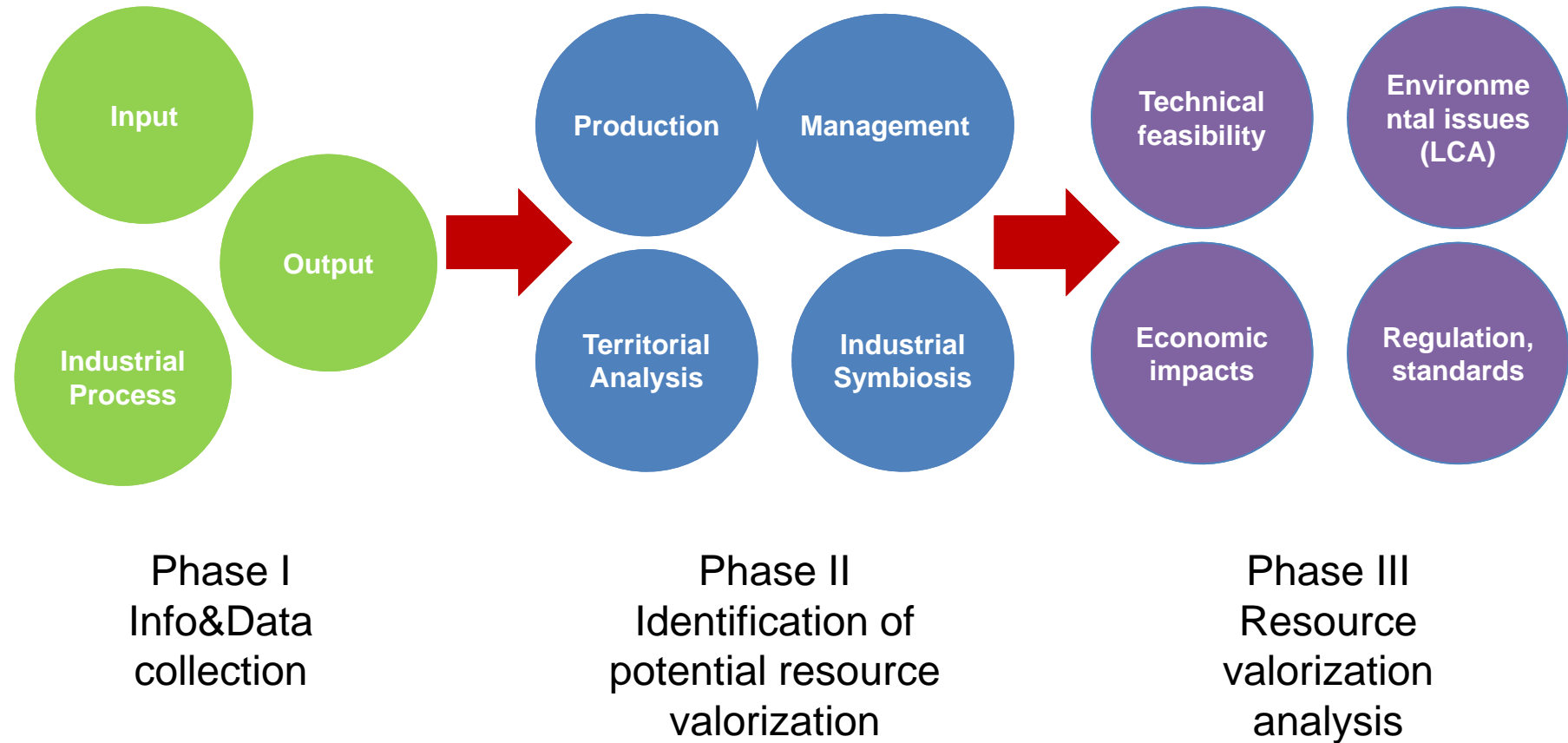
Knowledge and expertise

SYMBIOSIS
Piattoforma di simbiosi industriale

Tool for firms (also SMEs) and other operators to activate resource sharing (materials, energy, water, logistics, expertise)

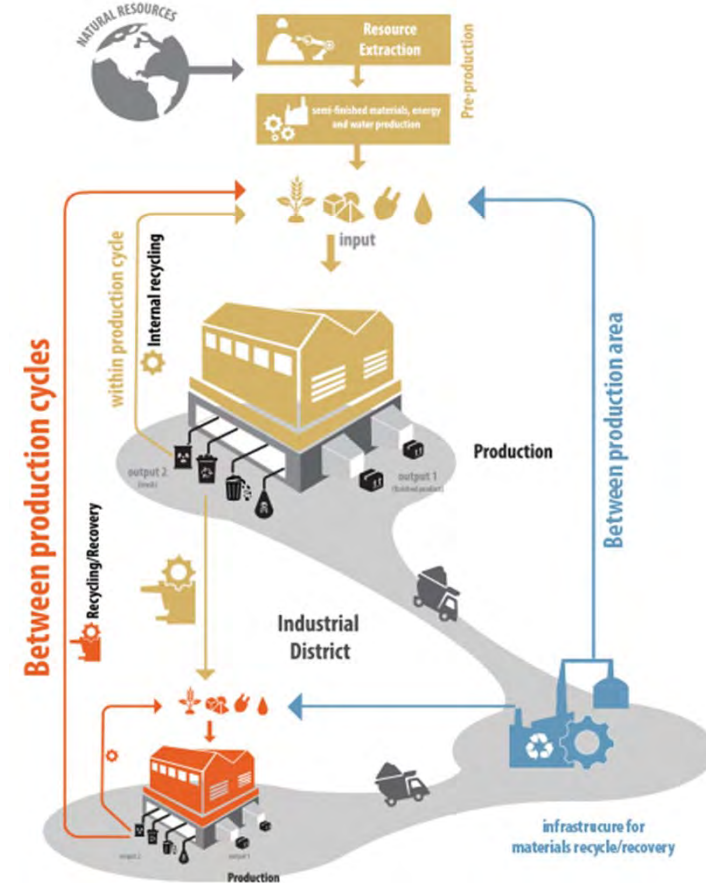
ENEA

ENEA's methodology for industrial symbiosis



STORM Project

STORM aims to implement a long term self-sustainable excellence network dedicated to provide services on the field of industrial symbiosis in the framework of a common language, methodologies and databases.



The European Commission assigned to industrial symbiosis a strategic role in the efficient use of resources, clearly identified in various planning and funding documents.

The actions of STORM will find complementarity with other symbiosis initiatives on EU market.

Circular Economy: Technologies

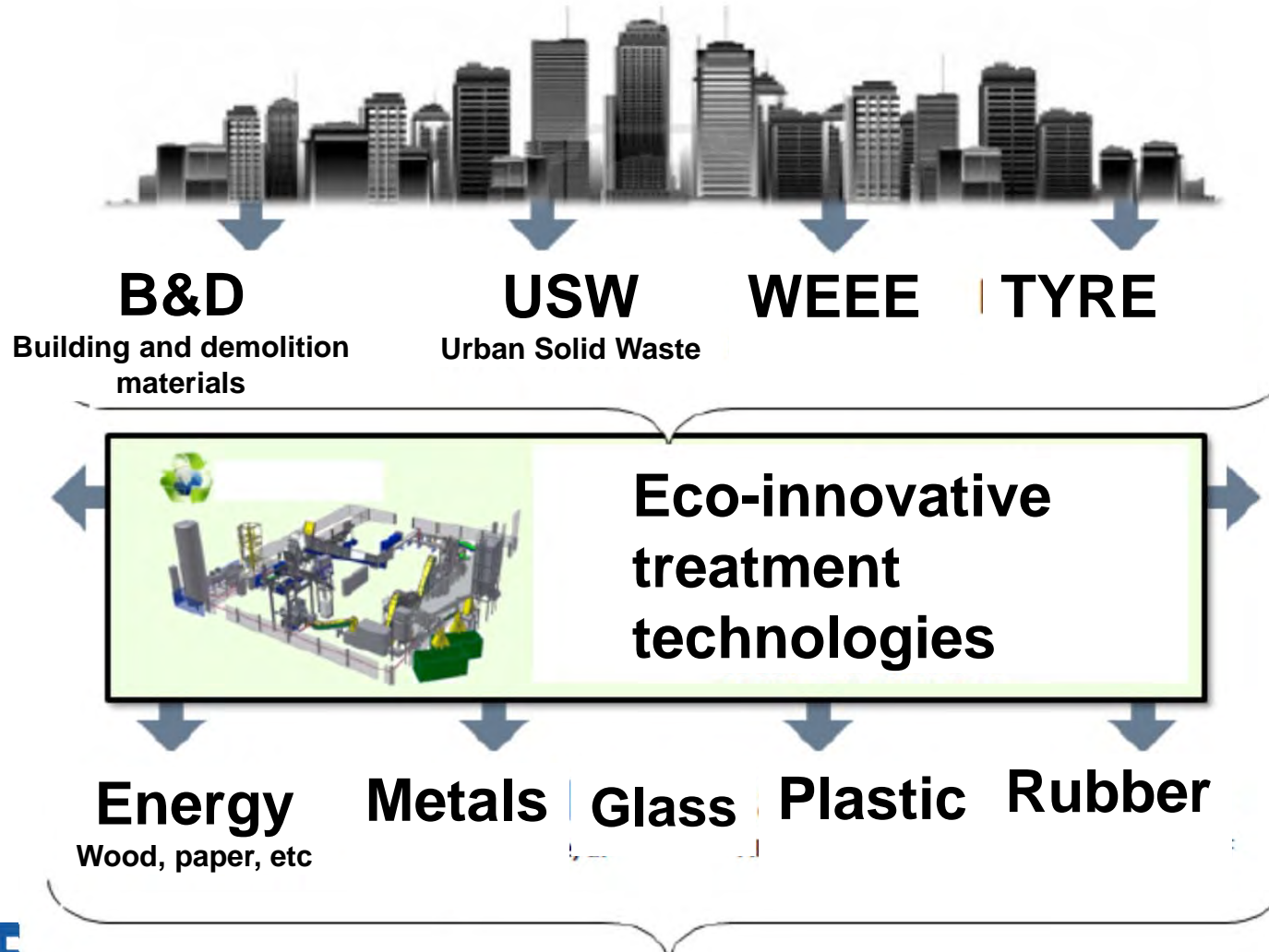


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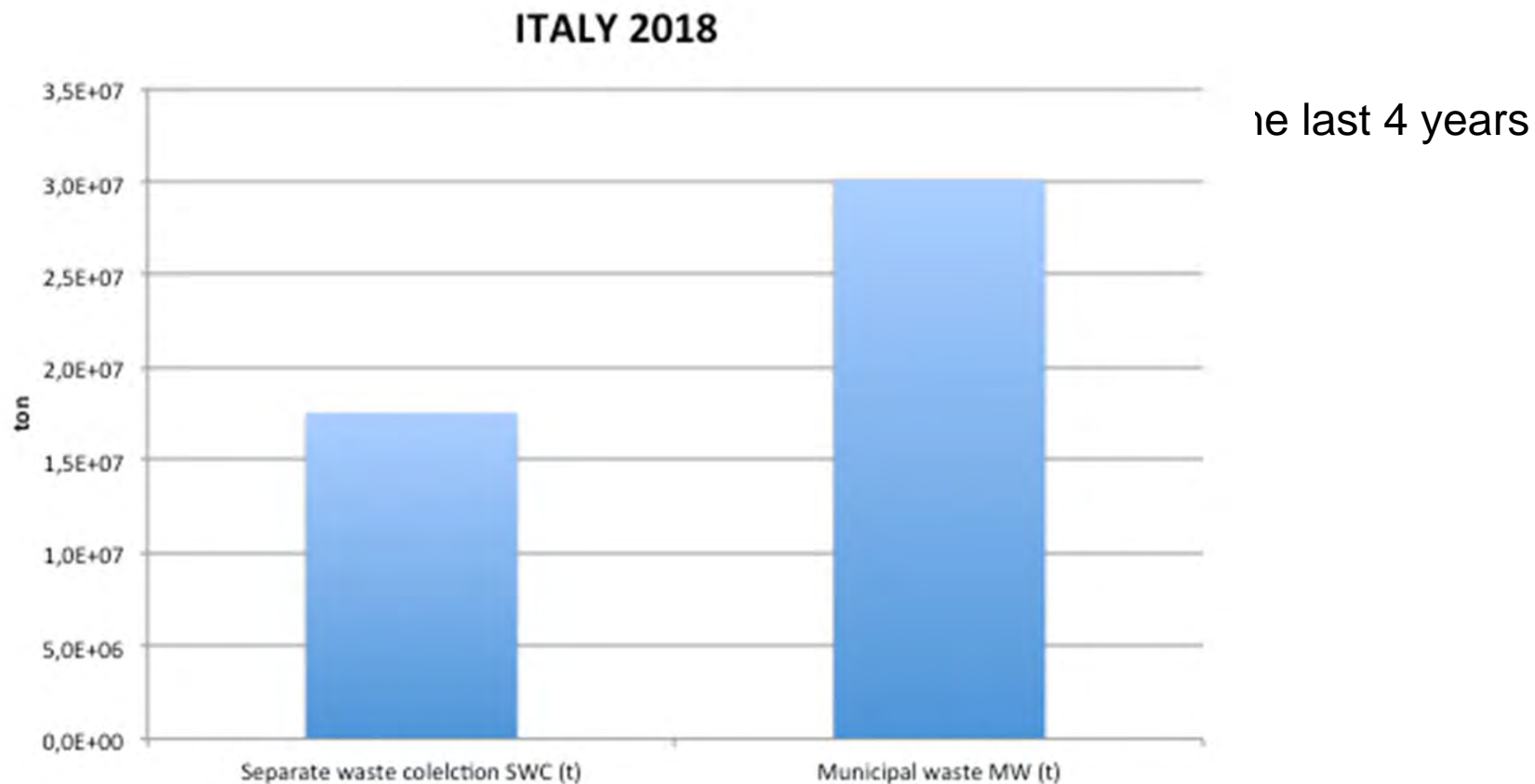


Municipal Waste: resource or problem?

Urban mines



Municipal Waste and Separate Waste Collection



SWC: 58,13 %

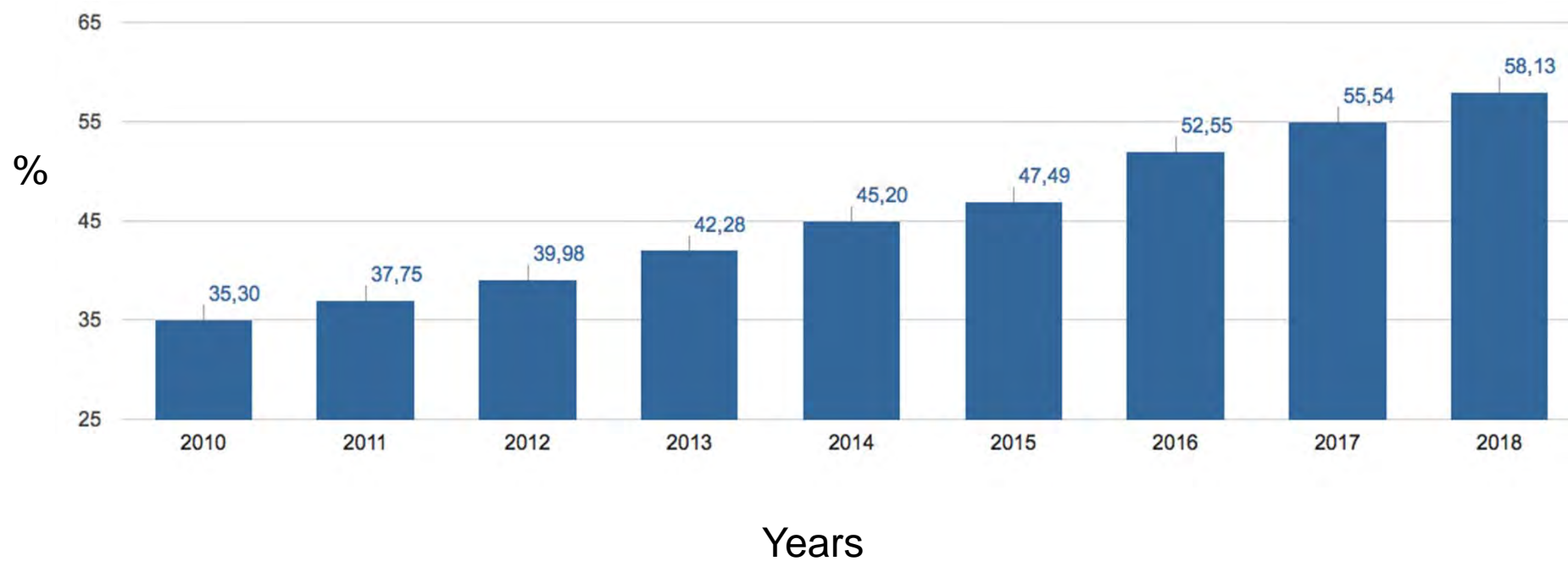
Italian population: 60.359.546

SWC per capita: 290,52 (kg/ab*y)

MW per capita: 499,75 (kg/ab*y)



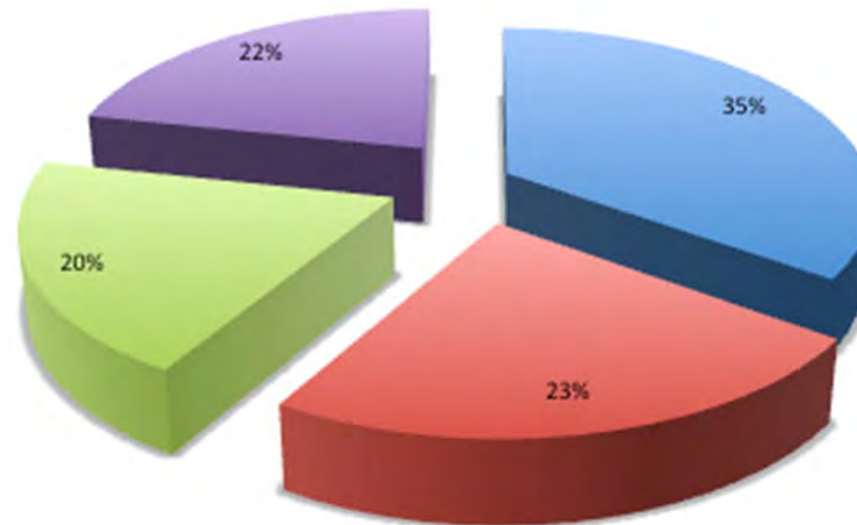
Italy. Trend of Separate Waste Collection



Treatments of Municipal Waste Italy

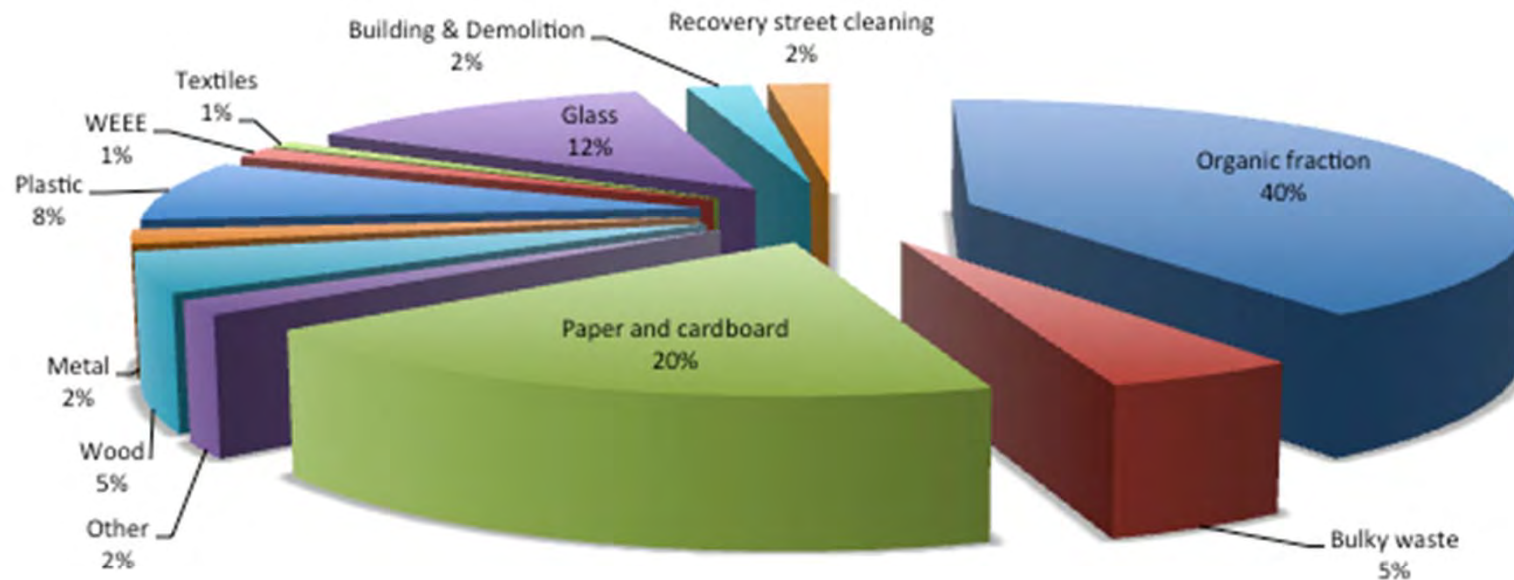
Treatments of Municipal Waste 2018

- Material recovery
- Biological treatment (composting, anaerobic and aerobic digestion)
- Incineration and co-incineration
- Disposal in landfill



Separate Waste Collection (2018)

Separate waste collection - Italy 2018



WEEE. The background

Some features that make very important the WEEE

- the fastest growing domestic waste stream in the world
- Every year around 50 Million tons of WEEE are generated and only 20% is disposed correctly

There is a collection problem. In Italy the ratio between the WEEE collected and EEE produced is 41.19%, where the European target is 65%.

Similar problems for other European

countries and in the world

The WEEE contain many materials (metals like Al, Cu, Fe, Ag, plastic, glass) which can be recovered and reused, thorough treatments.



Raw Materials recycling from WEEE – ENEA technologies



Printed Circuit Boards

- gold, silver, copper, tin, lead, palladium, plastics



Lithium batteries

- lithium, iron



LCD flat screens

- indium, tin



Photovoltaic panels

- metal electrodes
- glass, silica



Fluorescent lamps

- rare earths
- antimonium, manganese



Permanent magnets (Hard disk)

- Rare earths

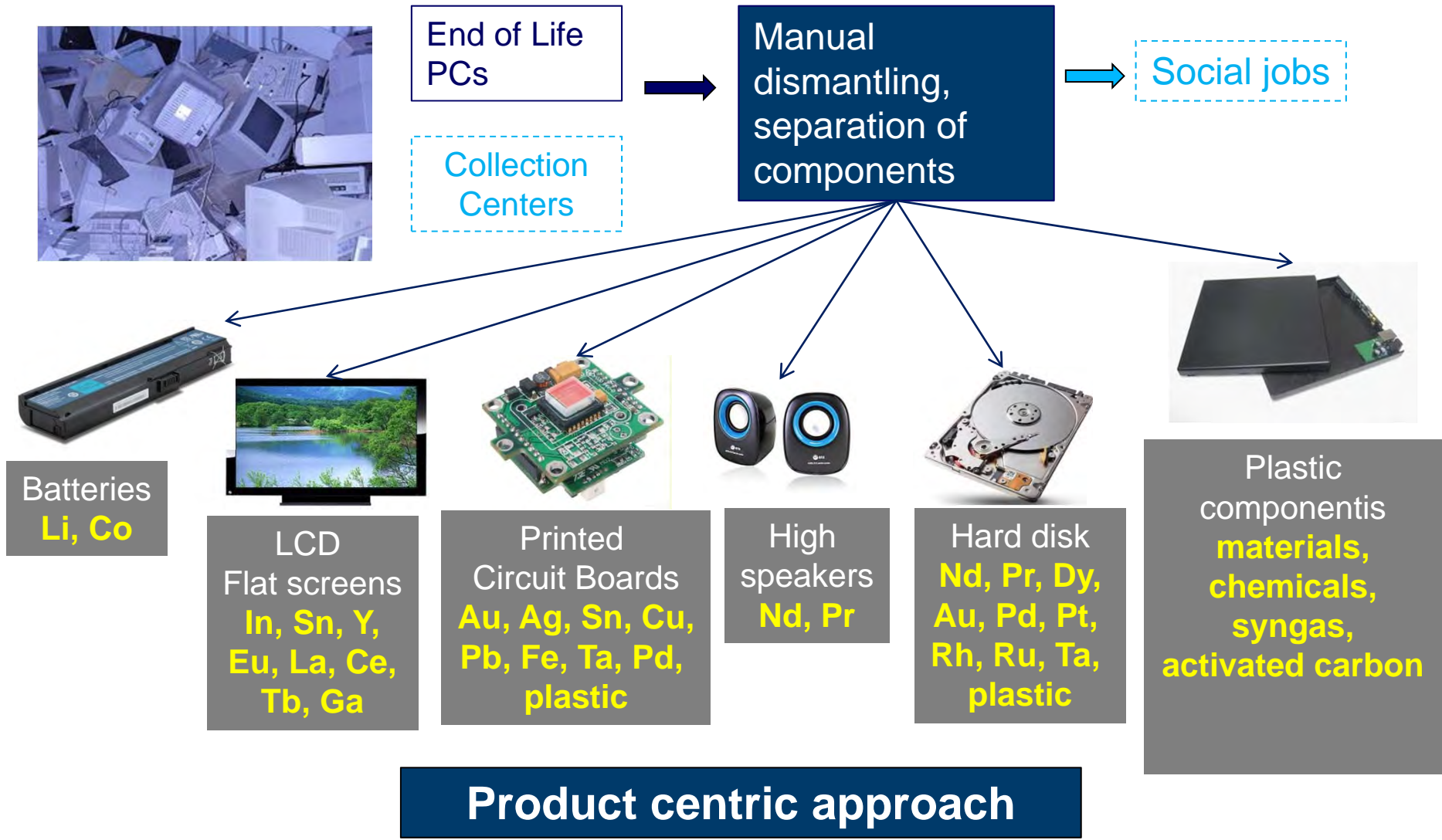
Raw Materials recycling from PCBs

- Patented process: RM2013A000549, PCT/IB2014/065131, EP nr 14798963.6
- Prototype: RM2015A000064, PCT/IB2016/050763
- Contact danilo.fontana@enea.it

Raw Materials recycling from Photovoltaic panels

- Thermal pre-treatment for PV components separation – under patent process
- Contact: marco.tammaro@enea.it

Raw Materials recycling from WEEE – ENEA approach



ROMEIO pilot plant

Recovery Of METals by hydrOmetallurgy



- Flexible and modular pre-industrial pilot plant designed for raw materials recycling from PCBs, can be adapted to the recycling from other end of life complex products and industrial scraps and byproducts.

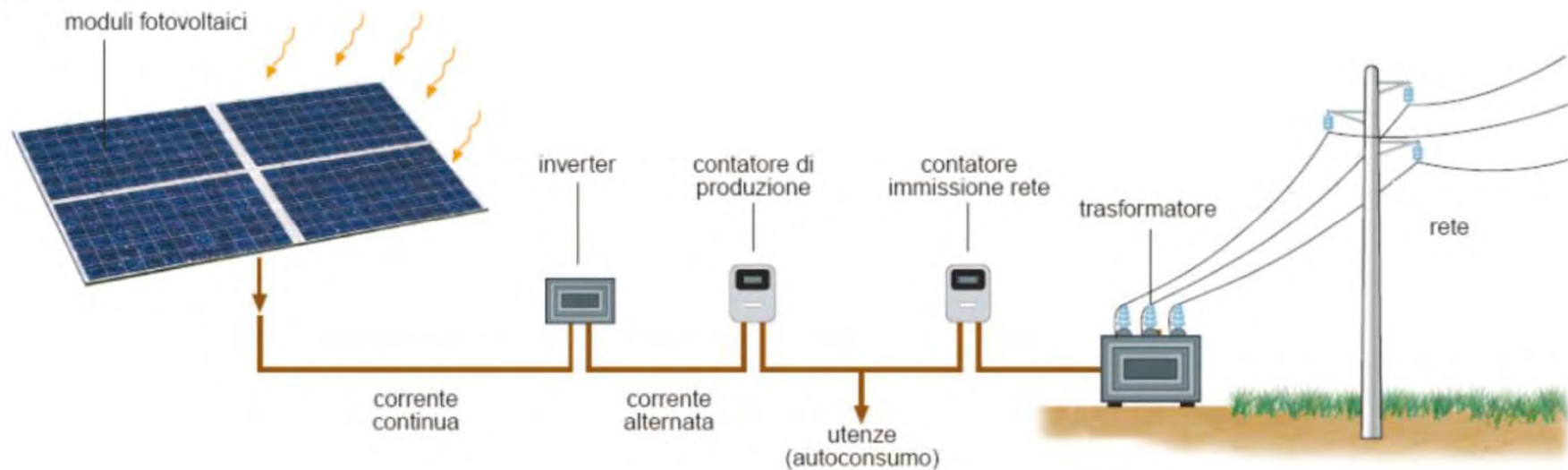
**Research Centre
CASACCIA
(Roma)**

WEEE. Case study by ENEA

Two Case studies for WEEE

- ✓ Photovoltaic panels at End of Life
- ✓ WEEE collection

Photovoltaic panels and end of life issue

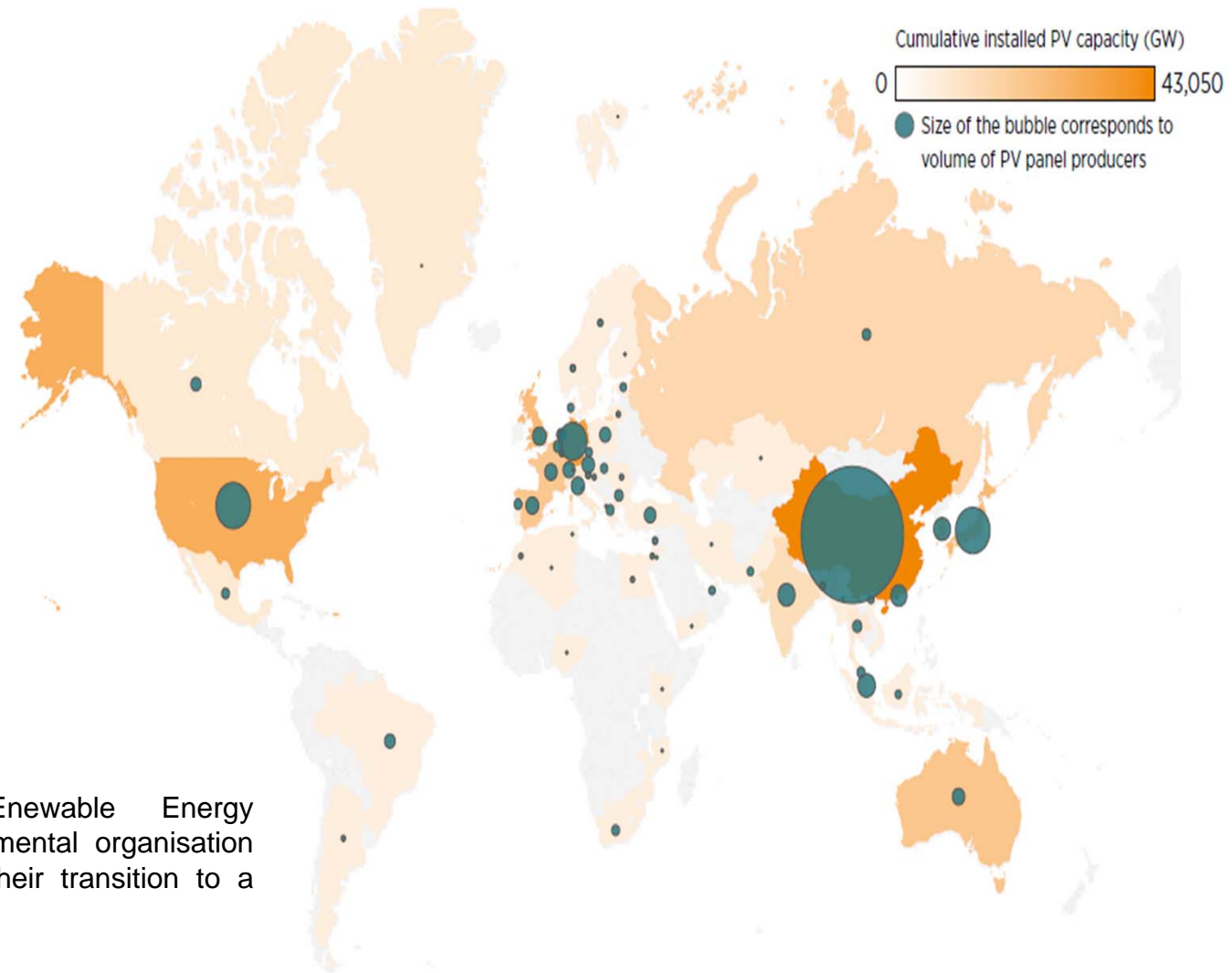


(Fonte GSE)

In the last 15 years, PV installations are increasing worldwide. This means that in the future we will have a PV waste management problem

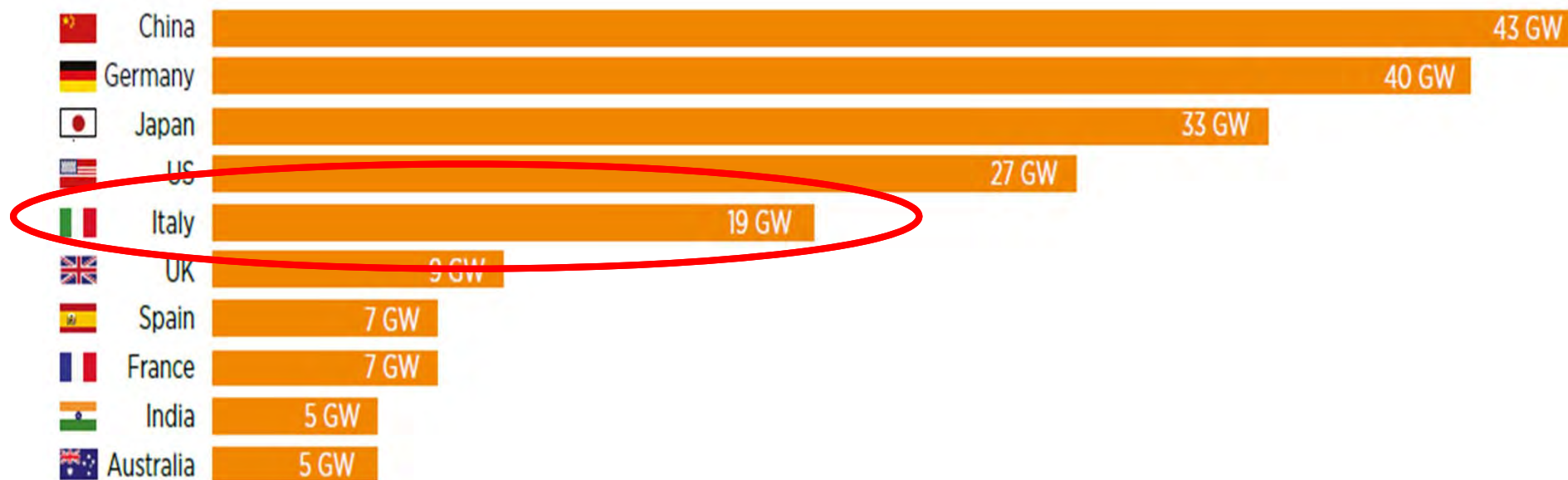
For each kWp : 8 – 10 m²

World overview of PV panels producers and cumulative installed PV capacity (2015)

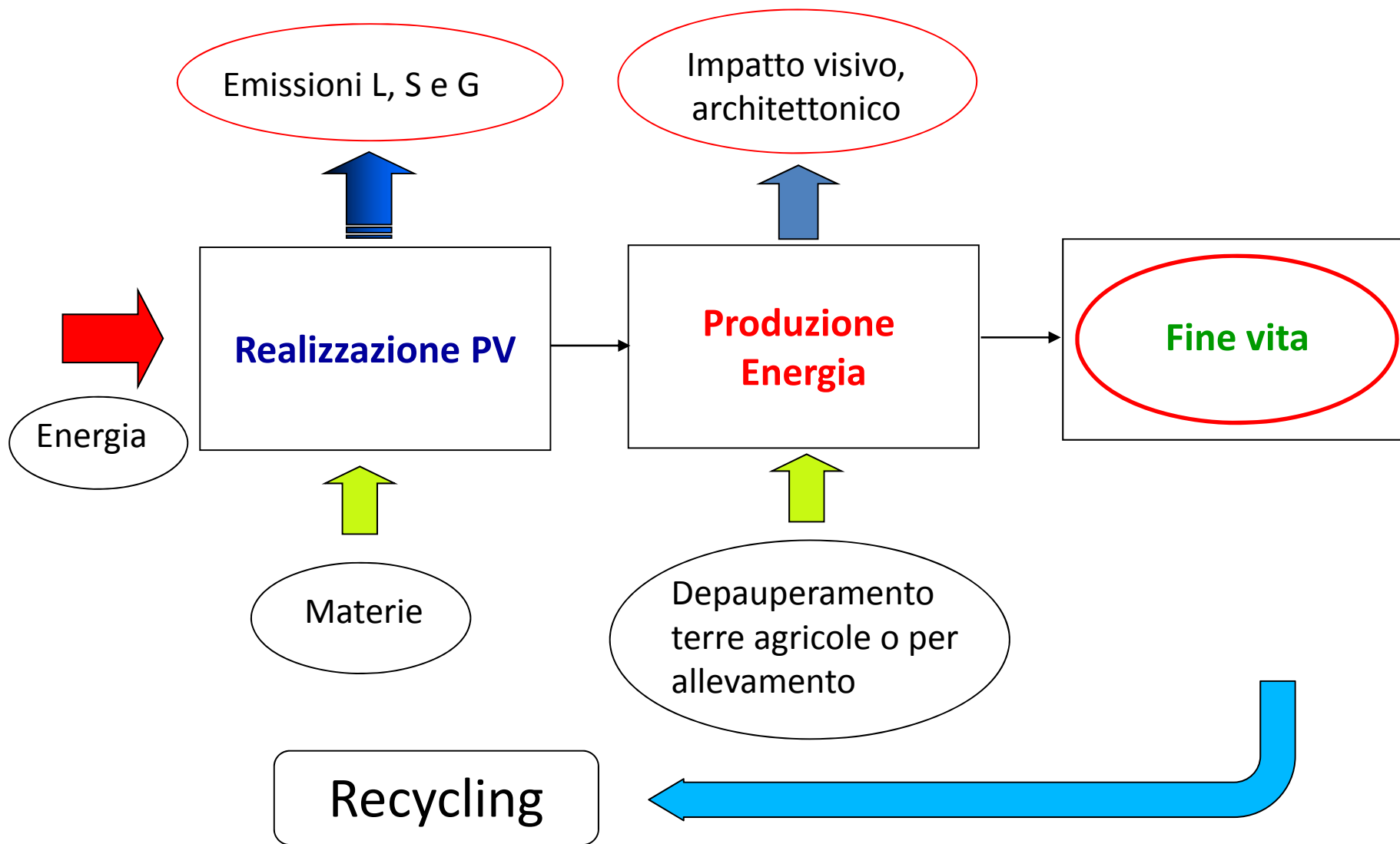


IRENA (International REnewable Energy Agency) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future.

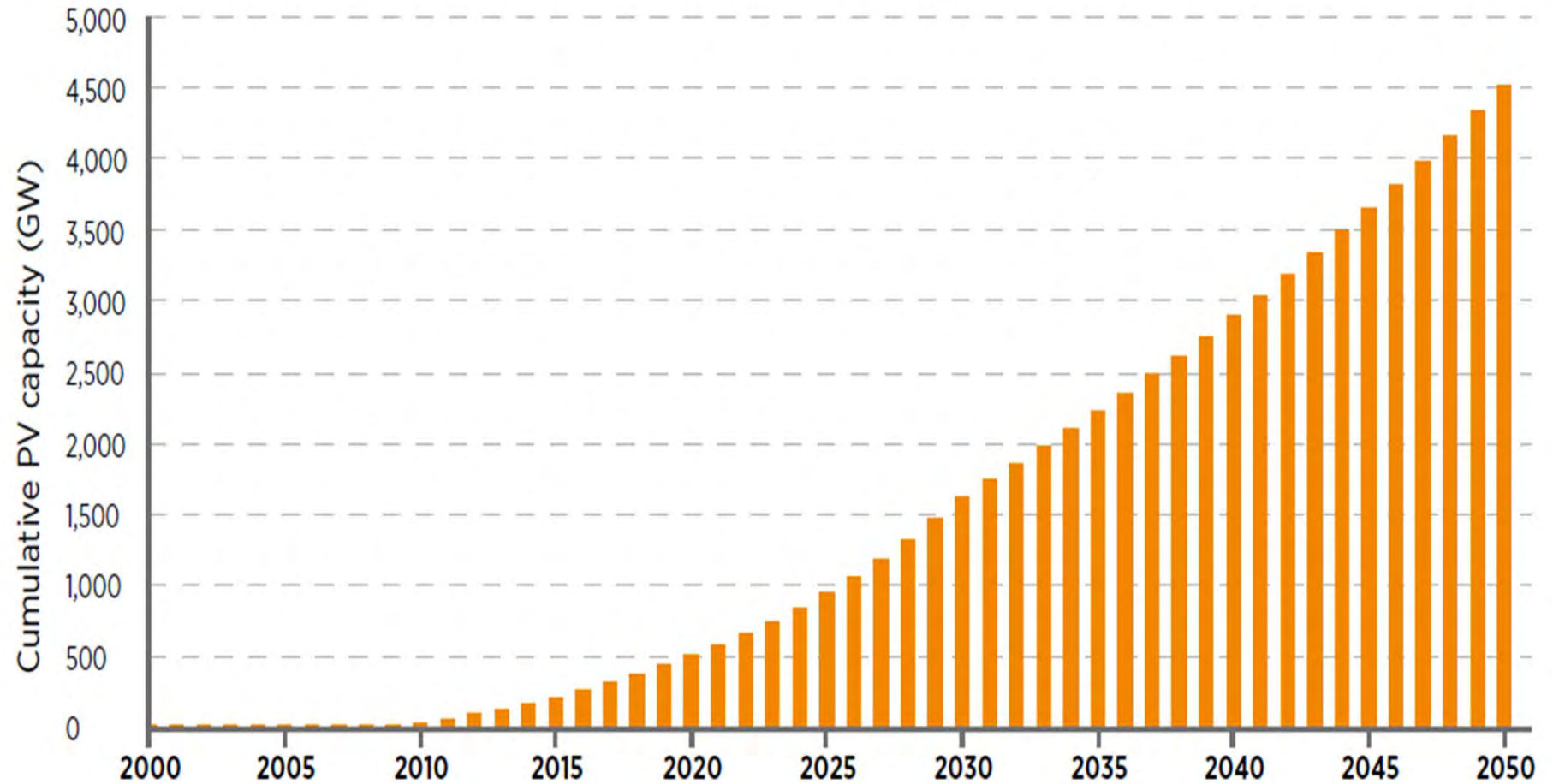
Top countries: cumulative installed solar PV capacity (2015)



Fasi di vita di PV

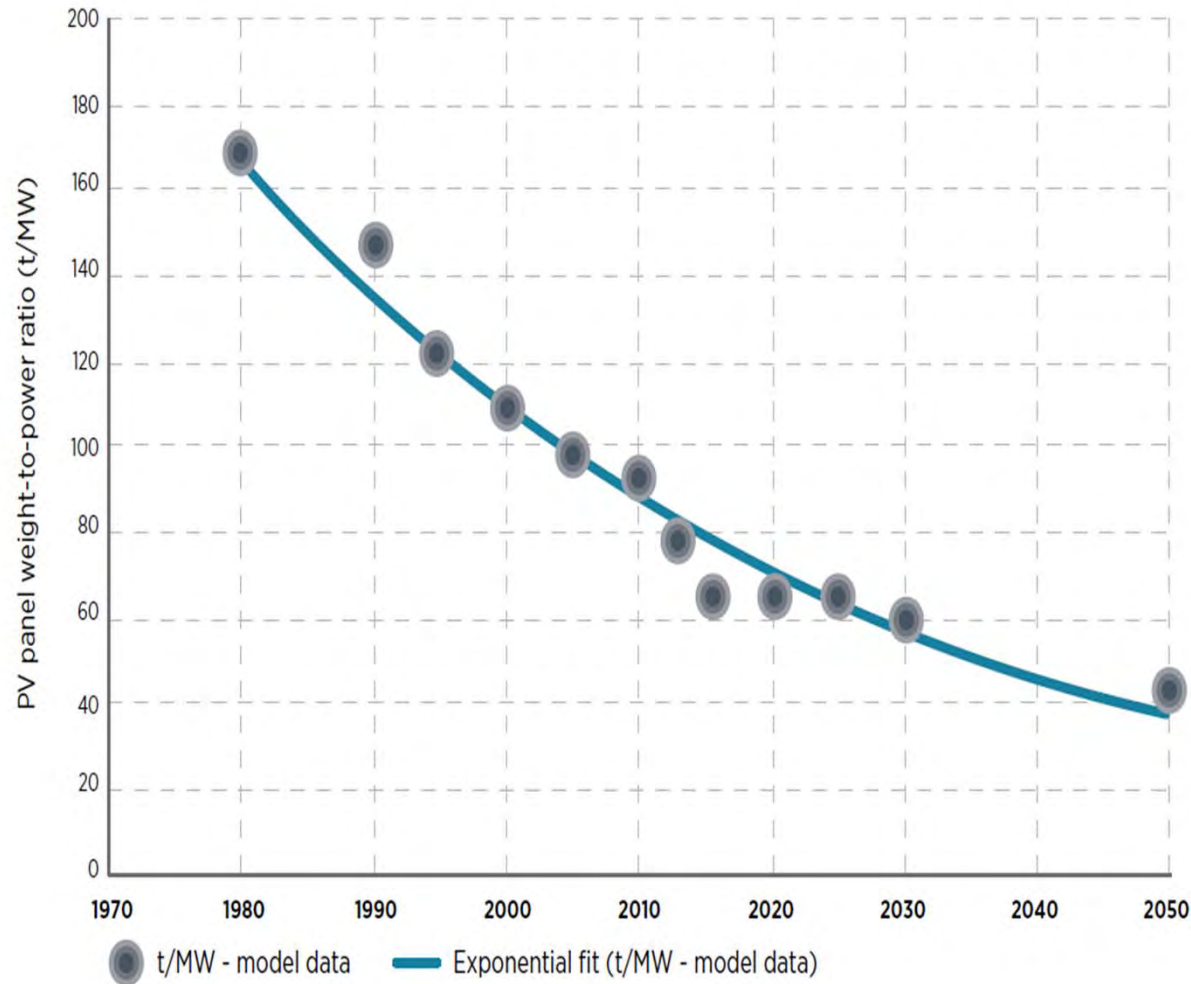


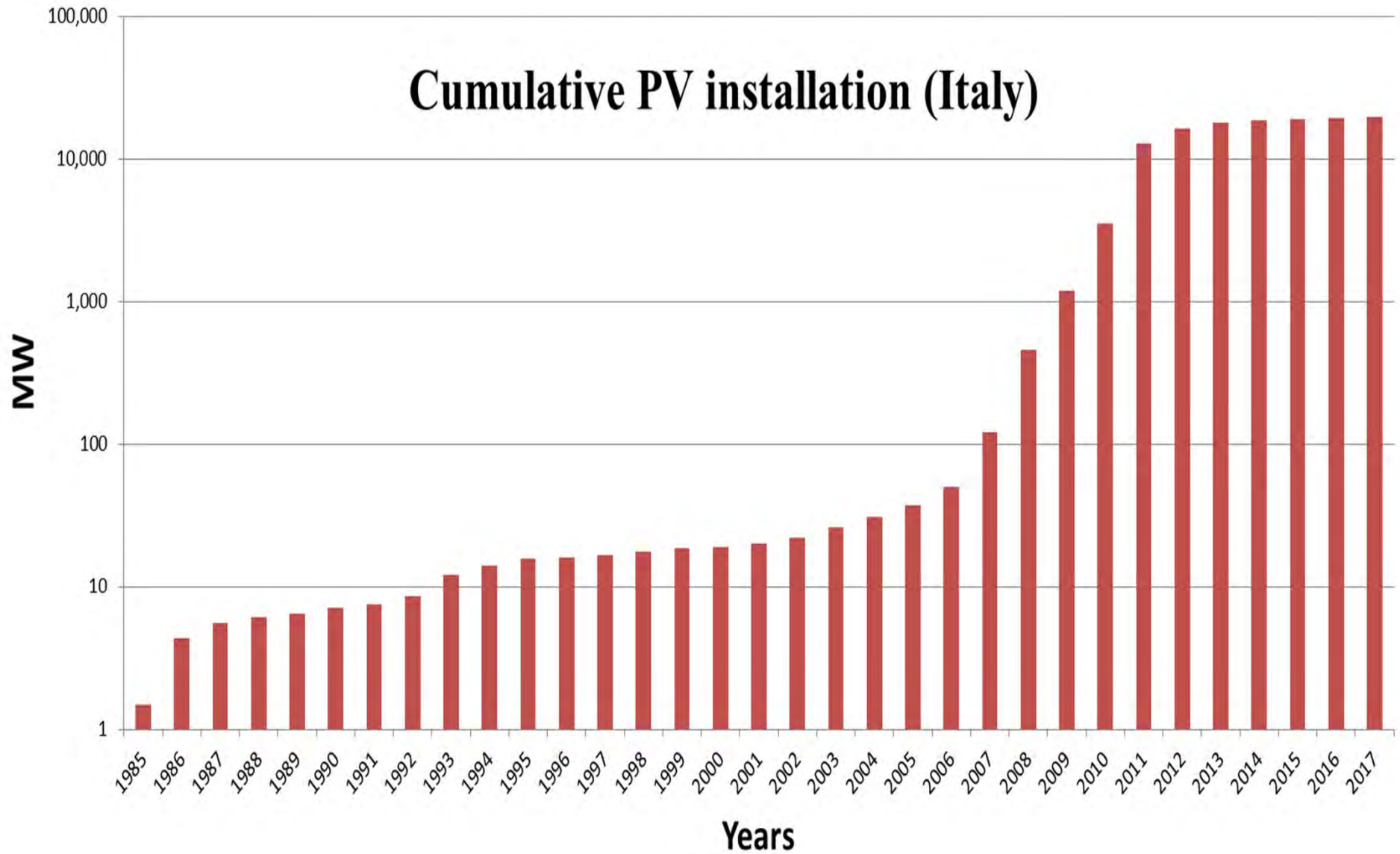
Projected cumulative world PV capacity



Based on IRENA (2016) and IEA (2014)

Potential curve fit of projection of PV panel weight-to-power ratio (t/MW)

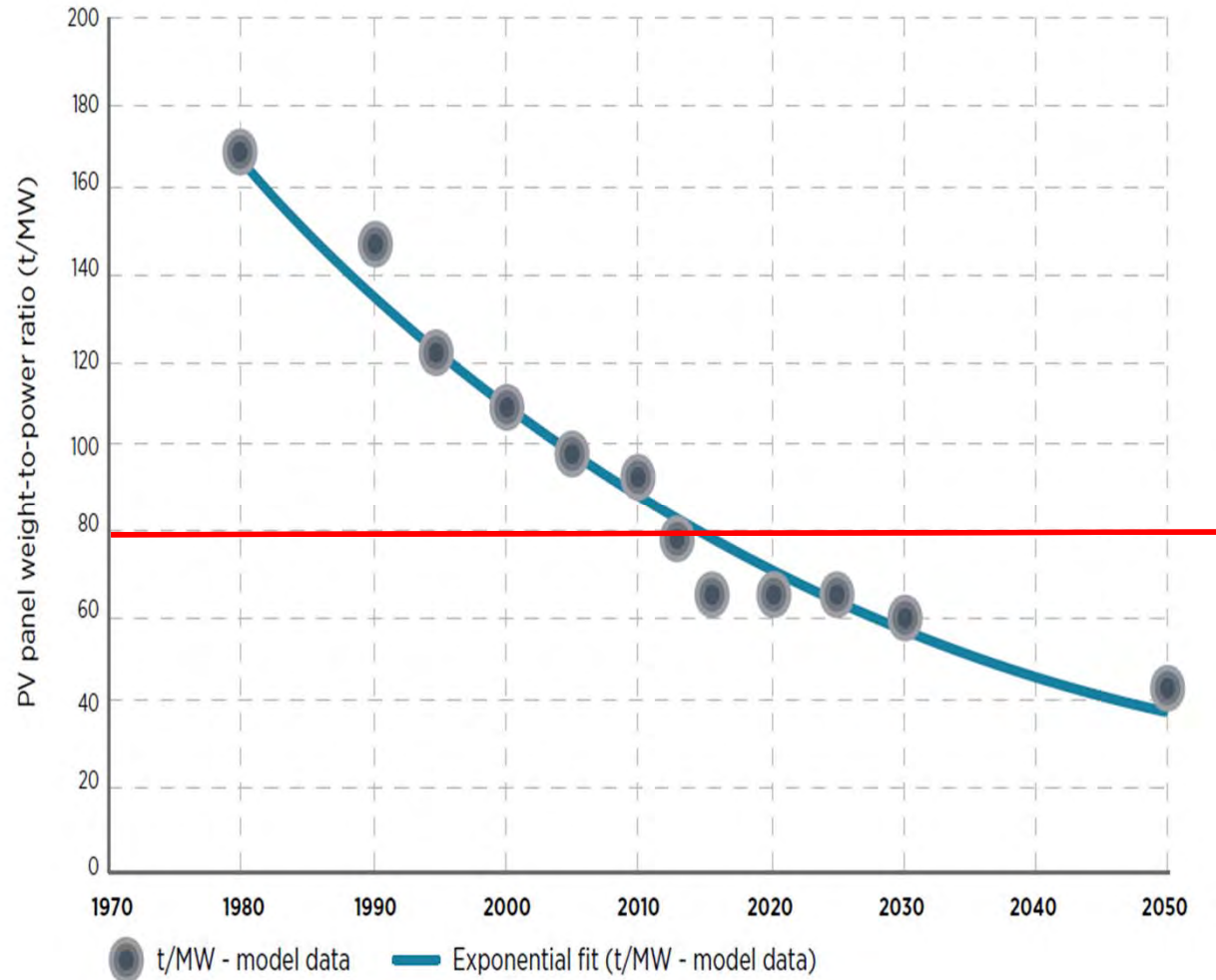




(sources: internet, technical report, scientific papers, GSE, etc.)

Potential curve fit of projection of PV panel weight-to-power ratio (t/MW)

Average value



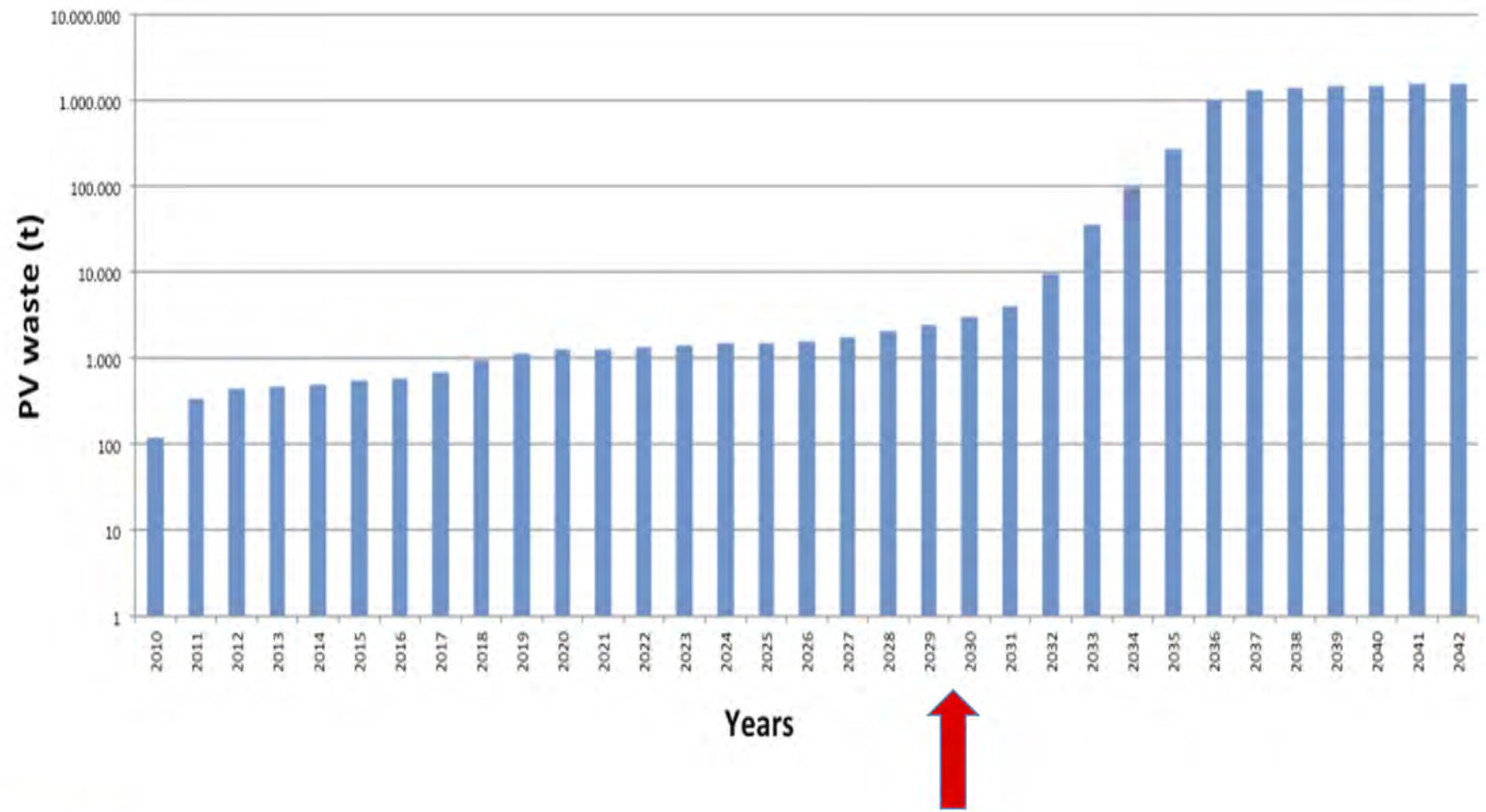
1 MW



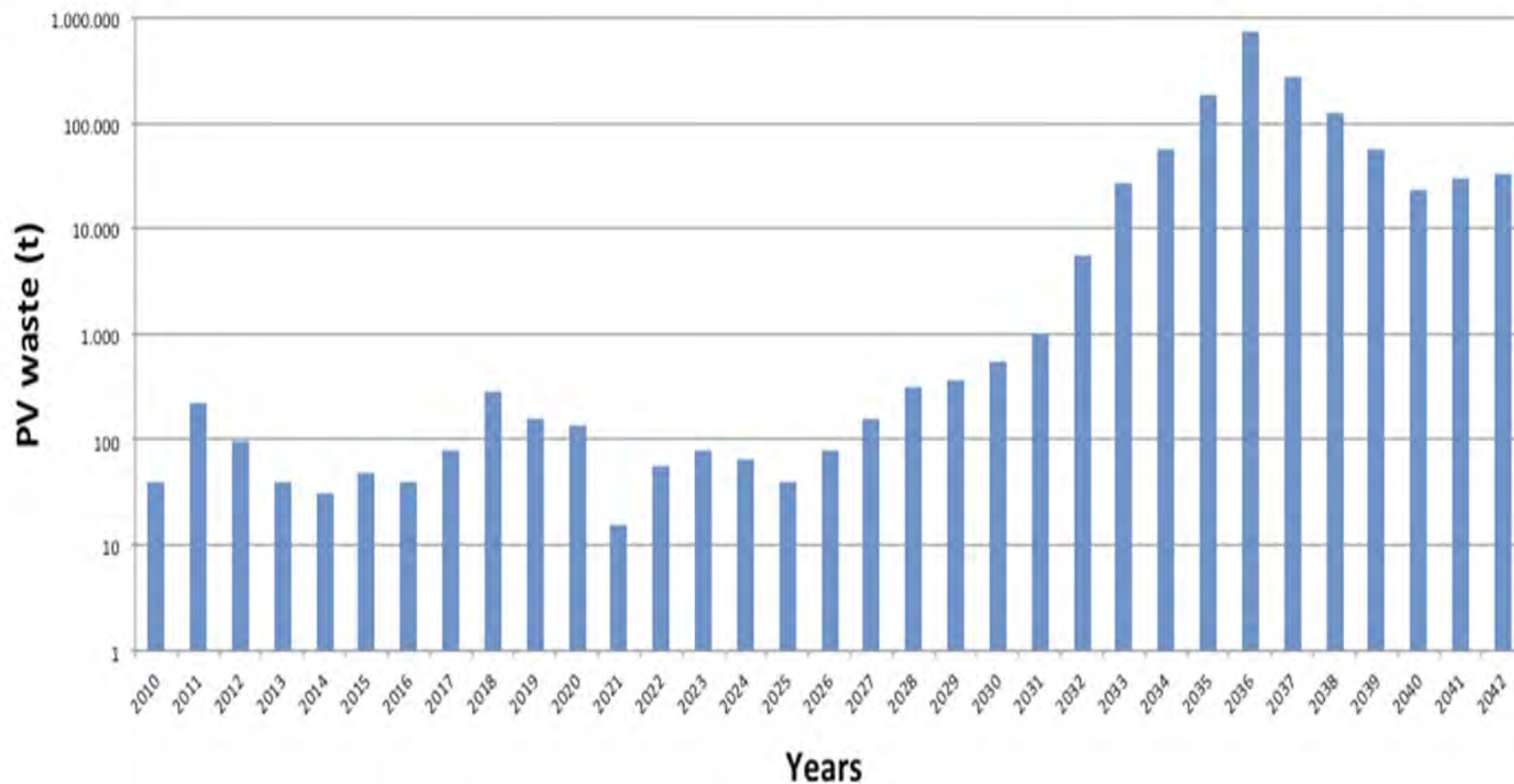
80 t waste

Life time = 30/25 years

Forecast of cumulative PV waste production in Italy (lifetime 25 year)



Forecast of PV waste production in Italy (no cumulative) (lifetime 25 years)



Normativa di riferimento

Percentuali di riciclaggio e recupero fissati dalla Direttiva 2012/19/UE (*Fonte: Direttiva 2012/19/UE*)

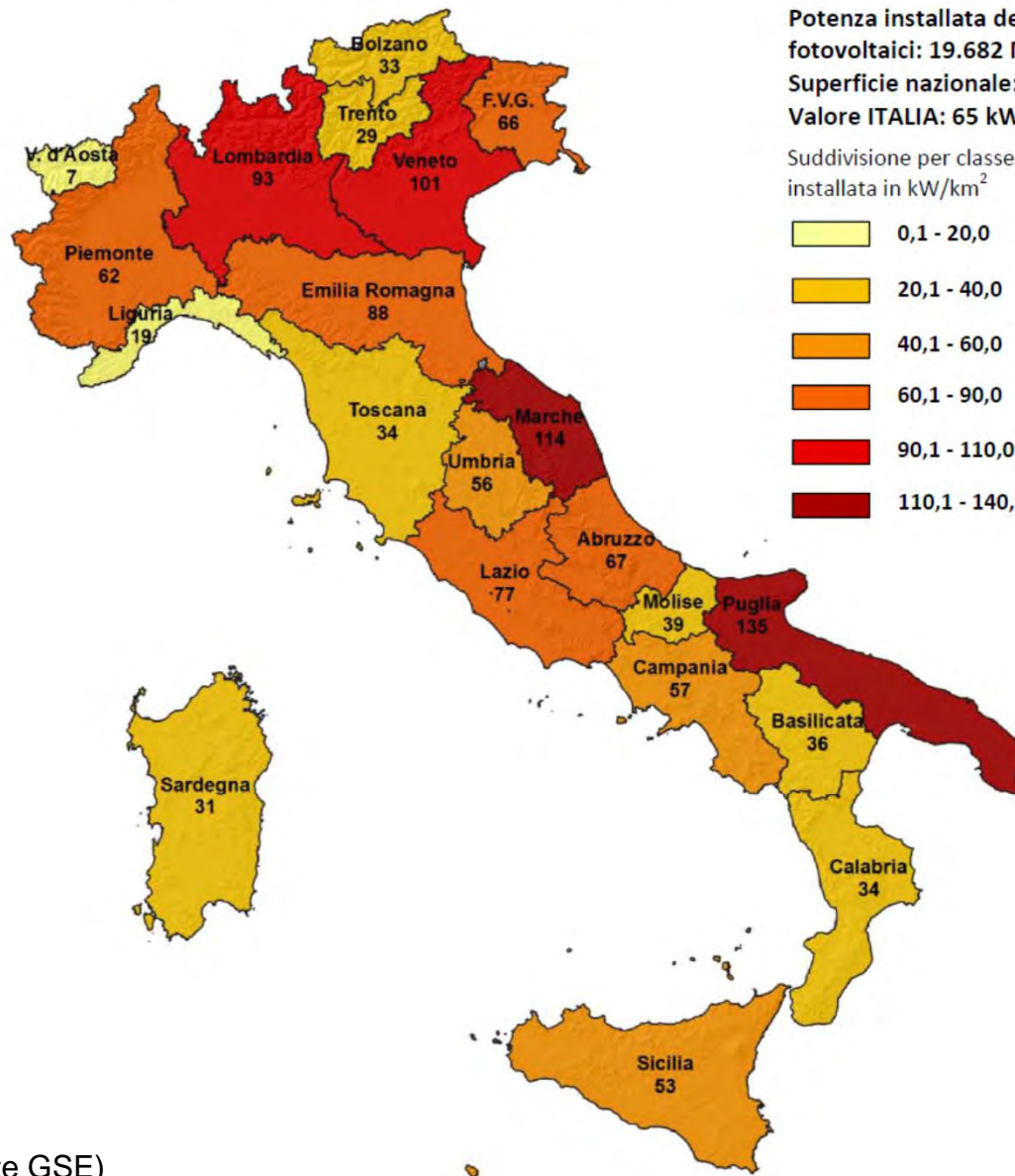
Periodo	Recupero (%)
Dal 13/08/2012 al 14/08/2015	75
Dal 15/08/2015 al 14/08/2018	80
Dal 15/08/2018	85

Cornice in alluminio + vetro ~ 85 %

D.lgs 49/2014

Il Decreto "Attuazione della direttiva 2012/19/UE sui rifiuti di apparecchiature elettriche ed elettroniche (RAEE)", n. 49 di recepimento da parte dell'Italia della suddetta Direttiva, è datato 14 marzo 2014 ed è entrato in vigore il 12 aprile 2014.

Distribuzione regionale dei kW per km² a fine 2017



In totale occupano
circa 196 km²

La Lombardia detiene il primato in termini di **numerosità degli impianti**, seguita dal Veneto. In termini di **potenza degli impianti** è invece la Puglia la prima regione italiana, con 2.600 MW installati, segno della presenza di grandi impianti produttivi molto concentrati (stima: 26 km²).

Esiste un problema ambientale che si affronta con un approccio integrato tecnologico e di recupero dei siti

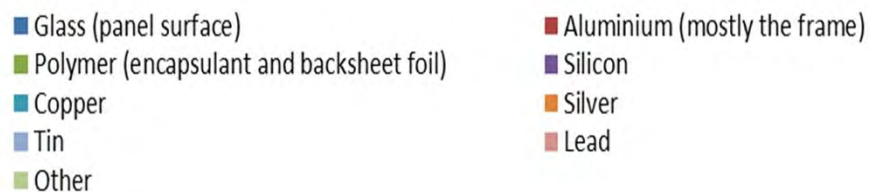
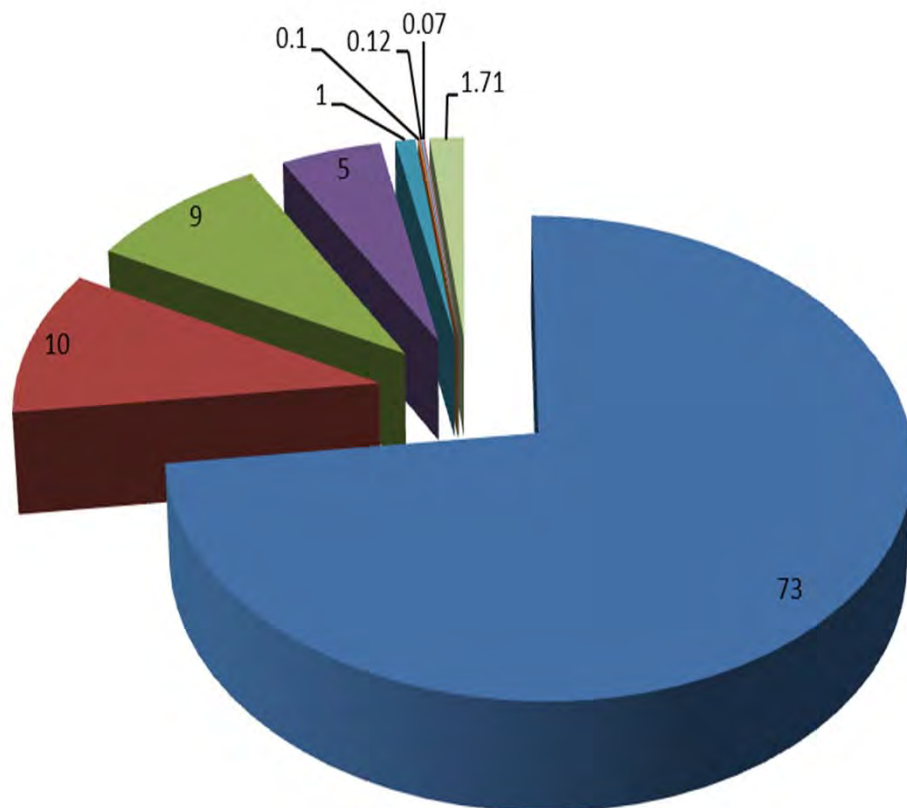
(Fonte GSE)



Contenuto di metalli

Tecnologia Fotovoltaica	Metalli
Silicio cristallino	Stagno, Piombo, Rame, Boro, Fosforo, Titanio, Argento, Alluminio
Silicio amorfo e microcristallino	Stagno, Piombo, Indio, Germanio, Zinco, Boro, Fosforo, Rame, Argento, Alluminio, Cromo
CdTe	Cadmio, Tellurio, Stagno, Indio, Rame, Piombo, Zolfo, Piombo, Argento
CIGS	Molibdeno, Rame, Indio, Gallio, Selenio, Cadmio, Zinco, Boro, Piombo, Argento, Alluminio

Panel composition crystalline silicon



	%	Kg
Glass (panel surface)	73	13.14
Aluminium (mostly the frame)	10	1.8
Polymer (encapsulant and backsheet foil)	9	1.62
Silicon	5	0.9
Copper	1	0.18
Silver	0.1	0.018
Tin	0.12	0.0216
Lead	0.07	0.0126
Other	1.71	0.3078

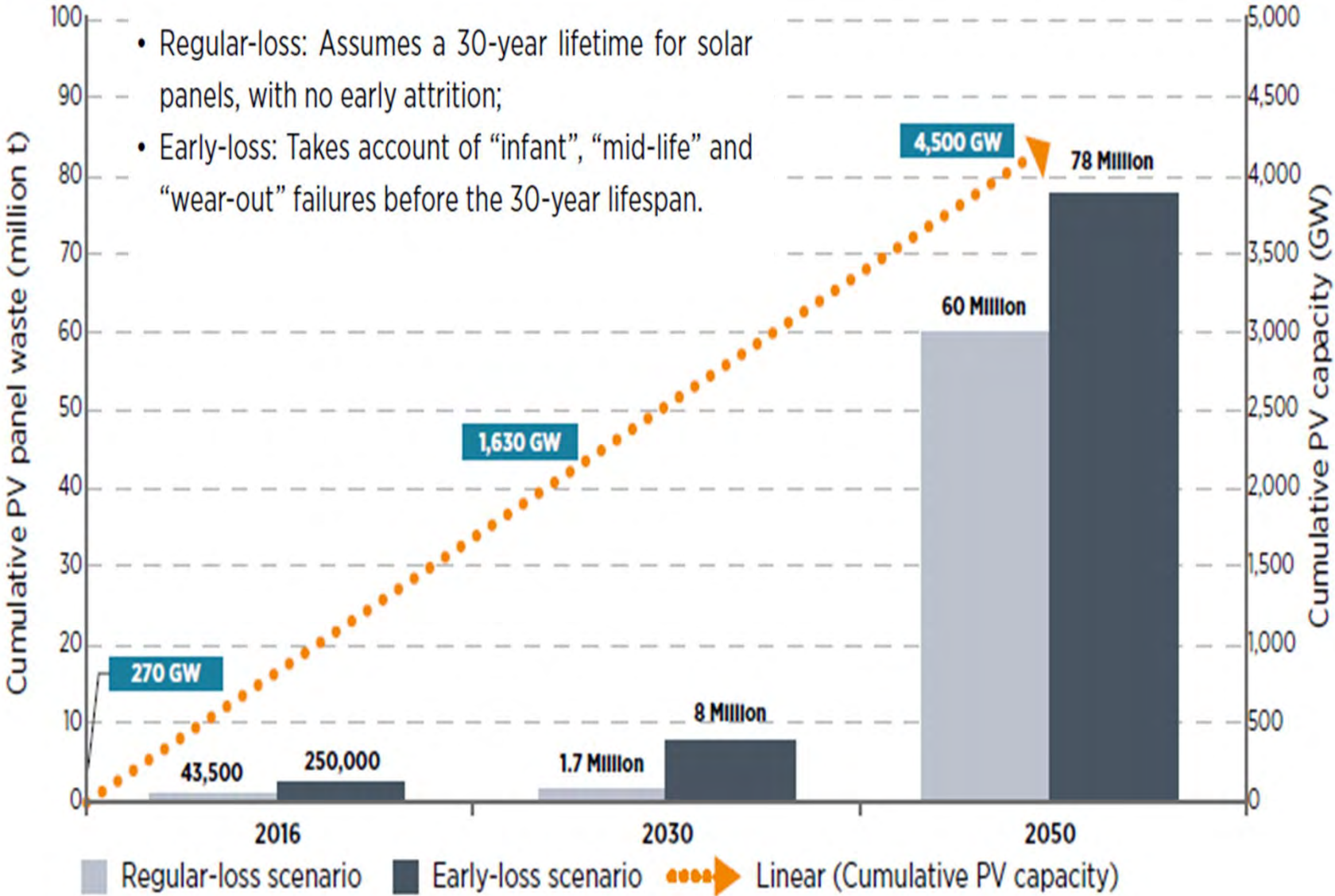
Panel composition (c-Si)

Average Weight: 18 kg

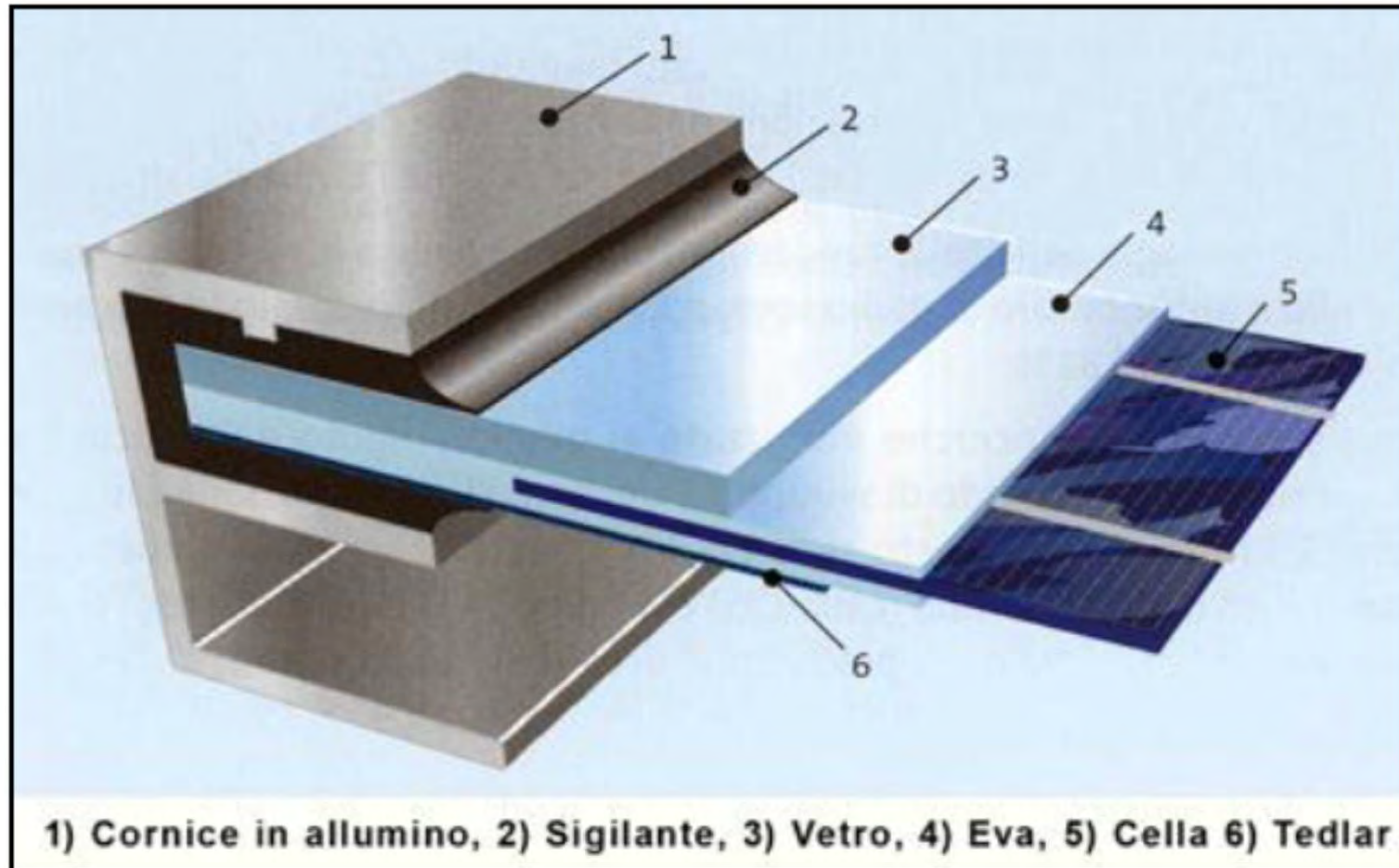
Forecast of material based on PV waste in Italy (no cumulative data) (lifetime 25 year)



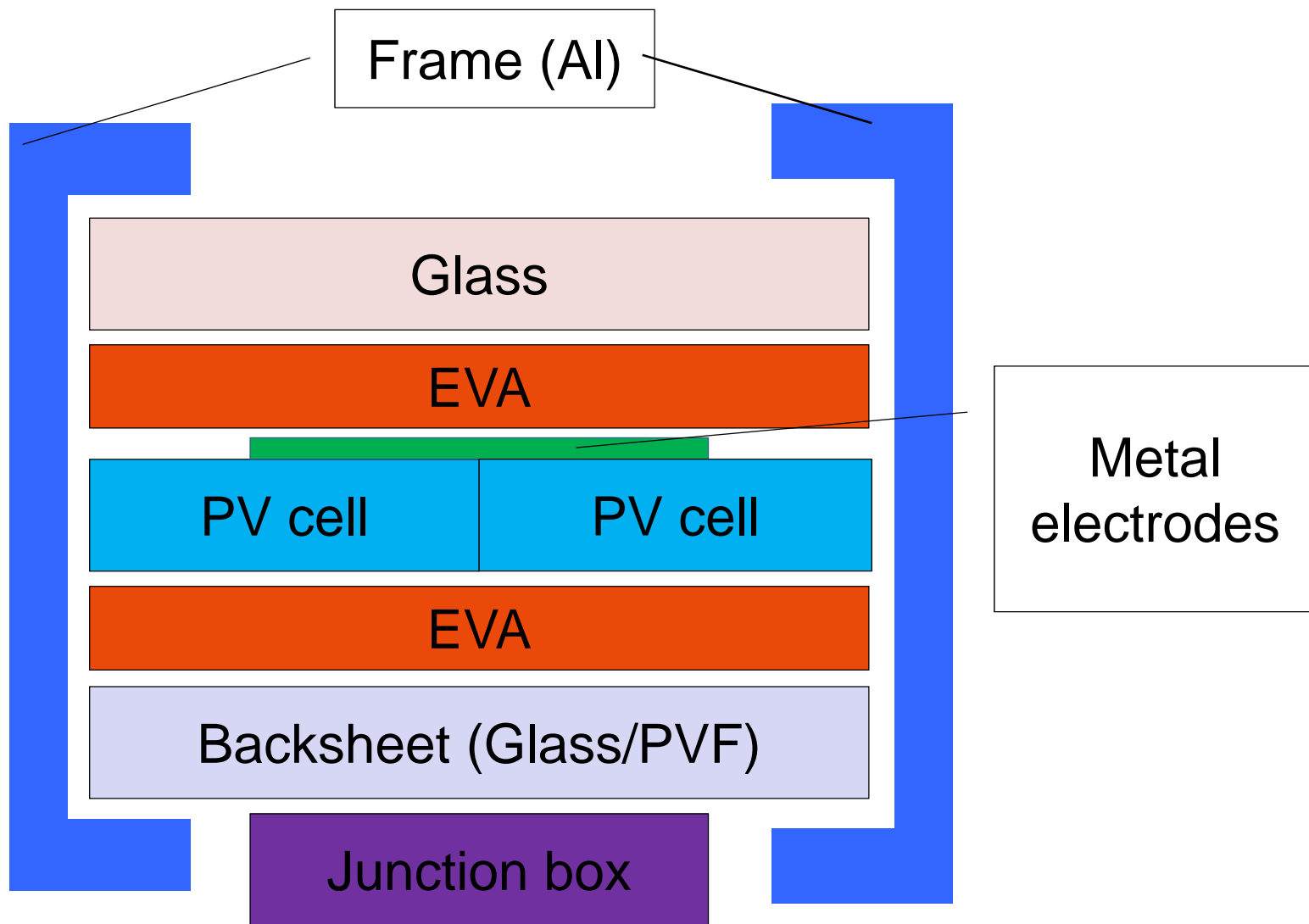
Overview of global PV panel waste projections, 2016-2050



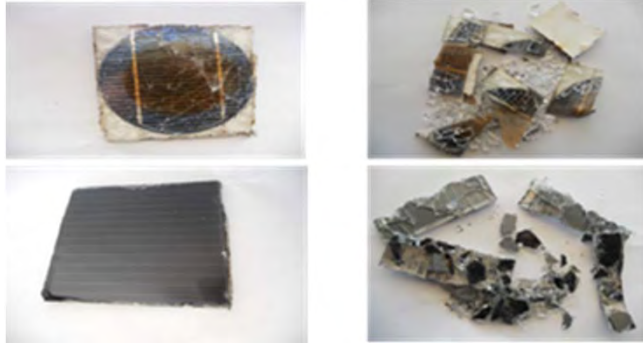
c-Si



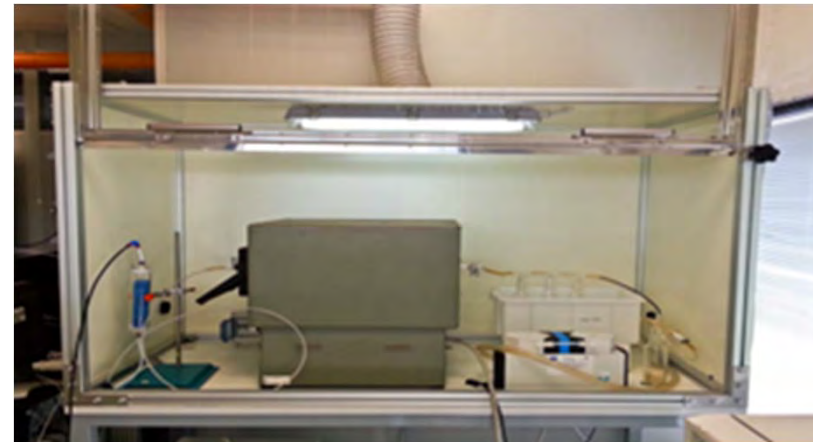
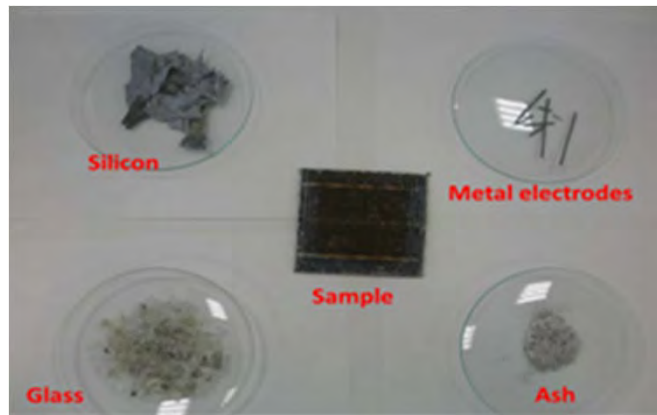
c-Si. Struttura a strati



Recovery of materials from PV panels at end of life. ENEA activities



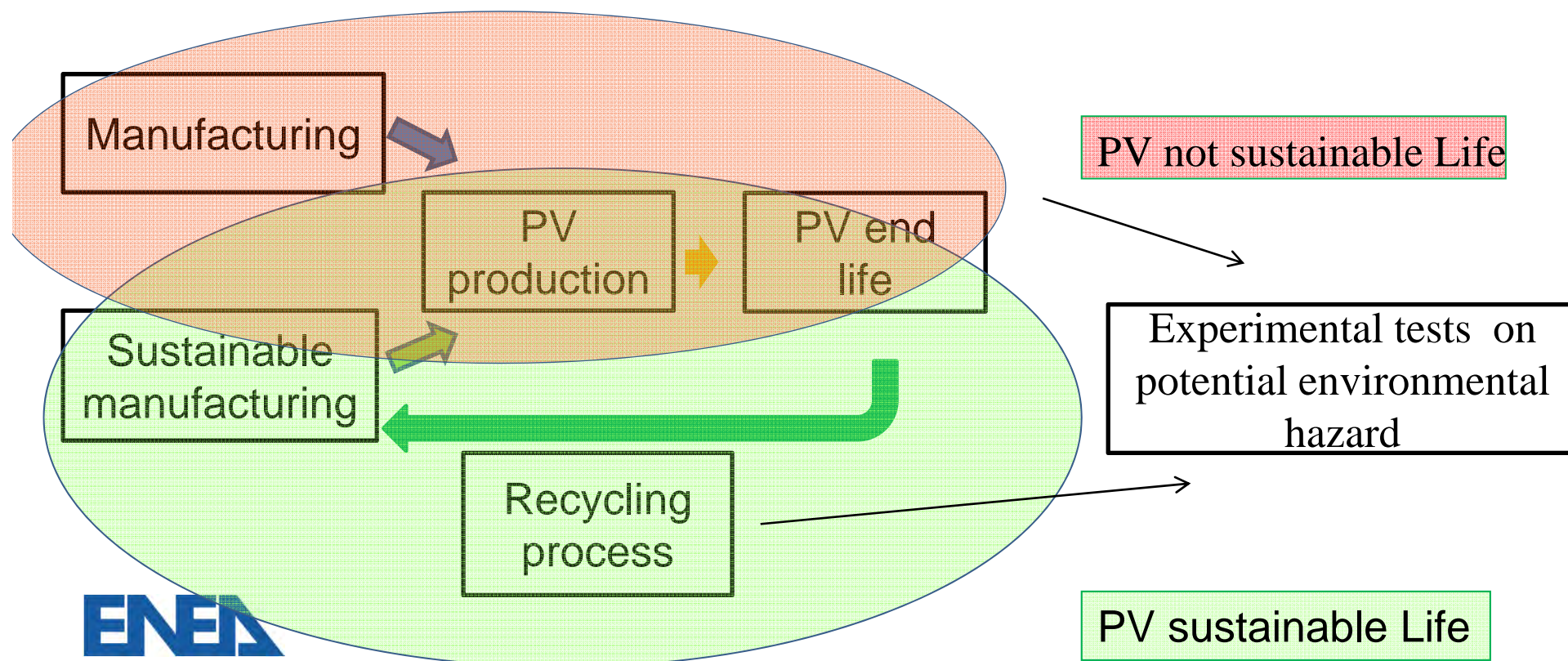
- ❑ Scientific paper
- ❑ International Research Projects
- ❑ Patent



The aim of these activities in ENEA are to find a sustainable way to recovery materials from panel

Objective of the investigation

The aim of these activities in ENEA were the experimental assessment of the amount of metals released in the environment from PV waste , in two cases: assuming an uncontrolled dumping and during a thermal treatment performed for recycling.

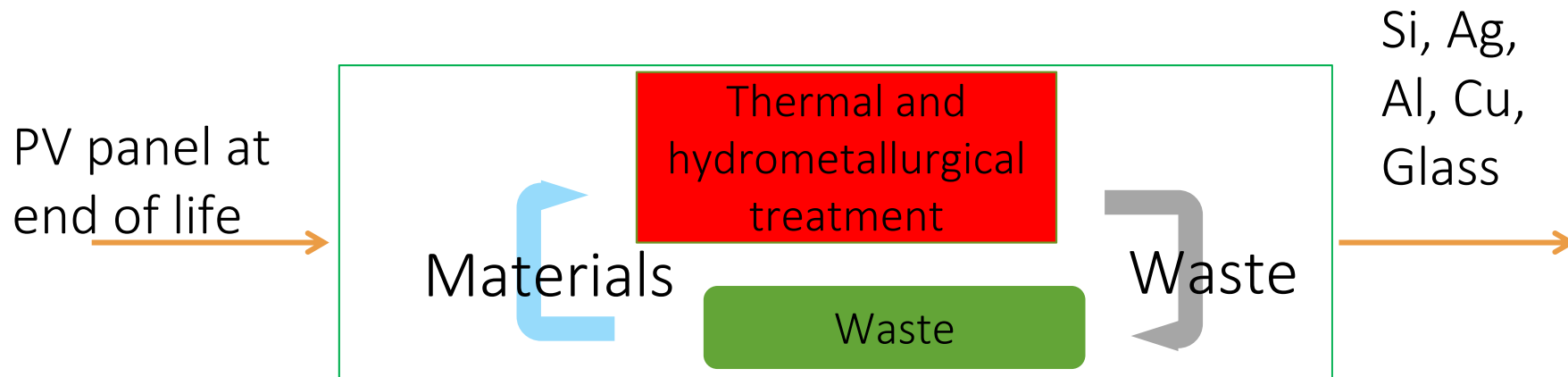


RESIELP

Recovery of Silicon and other materials from End-of-Life Photovoltaic Panels

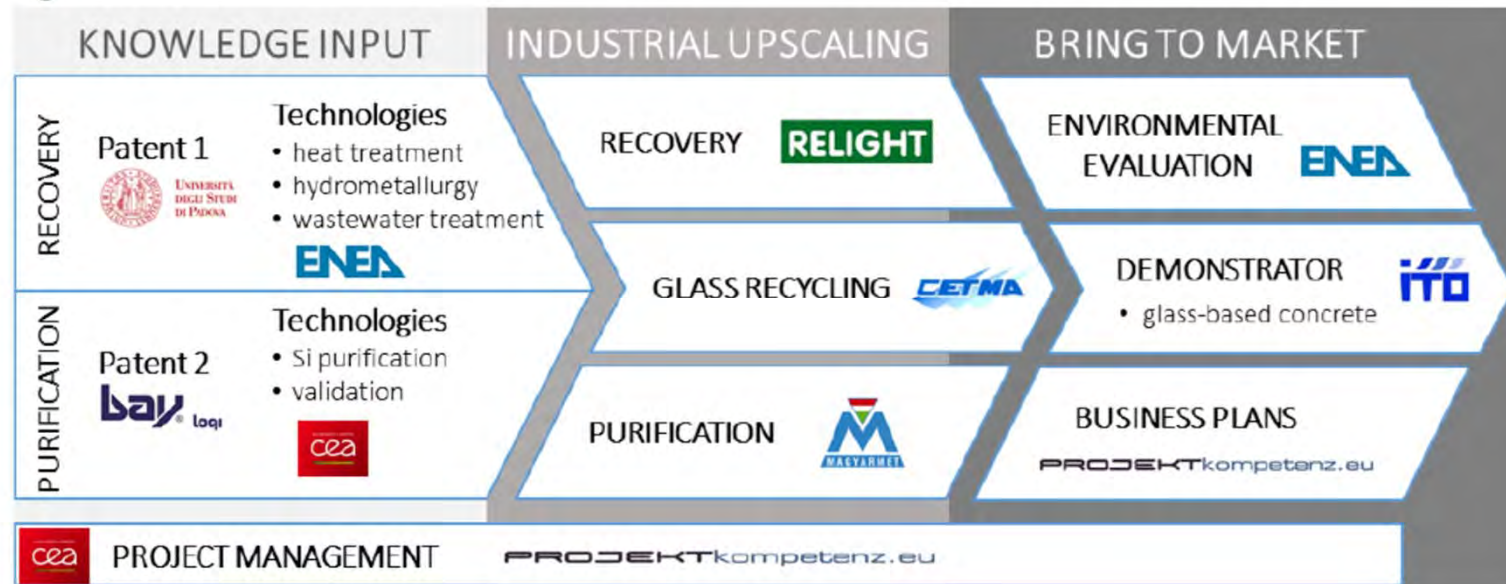
Project funded by the EIT KIC Raw Materials (European organization linked to the European Commission)

Realization of a zero-waste prototype for the treatment of photovoltaic panels at the end of their life aimed at recovering materials.



Thermal treatment at high temperature (600 °C)

RESIELP



Duration: 3 years

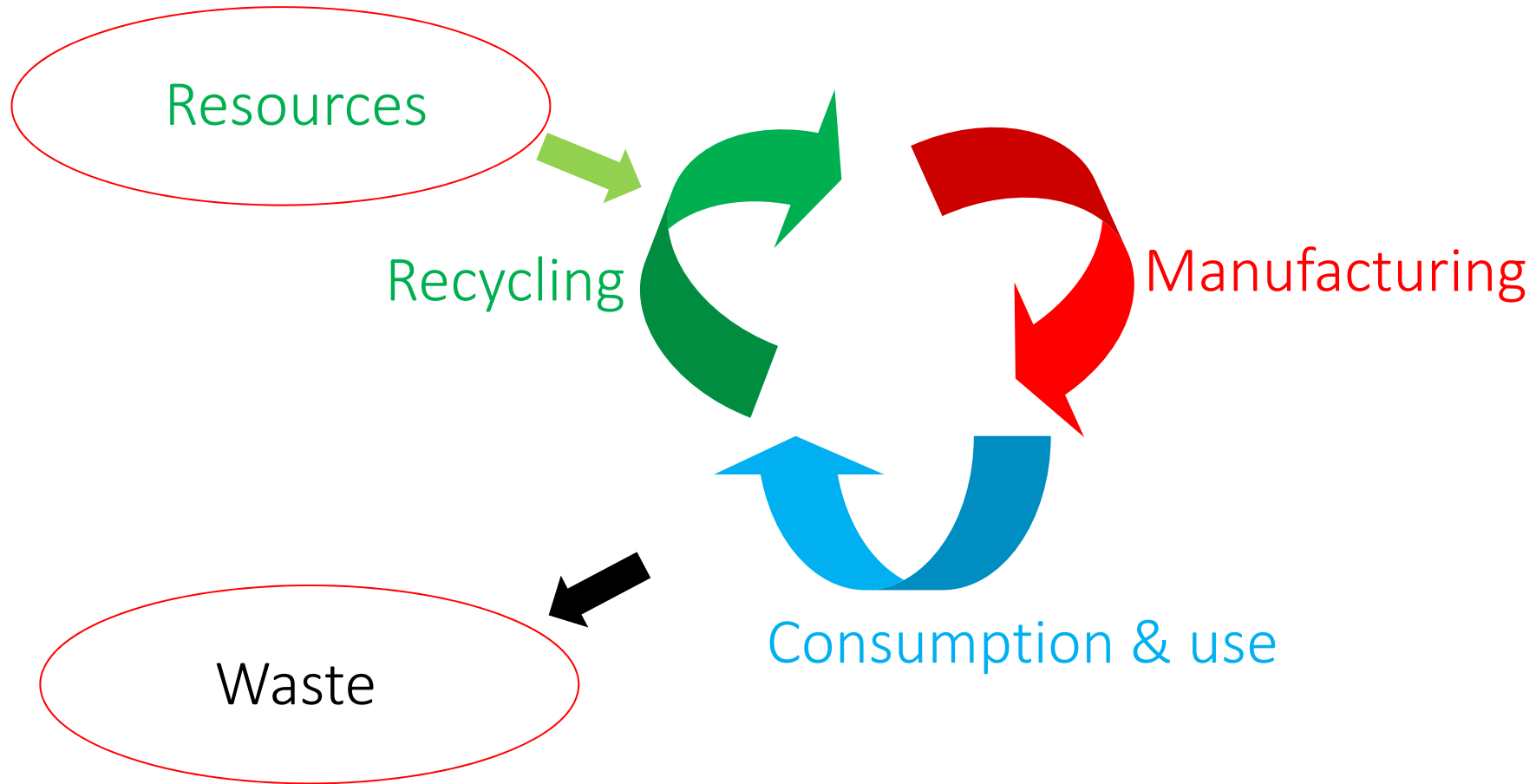
Start: 01/04/2017

End: 31/03/2020

Total funding: 2.495.689 €

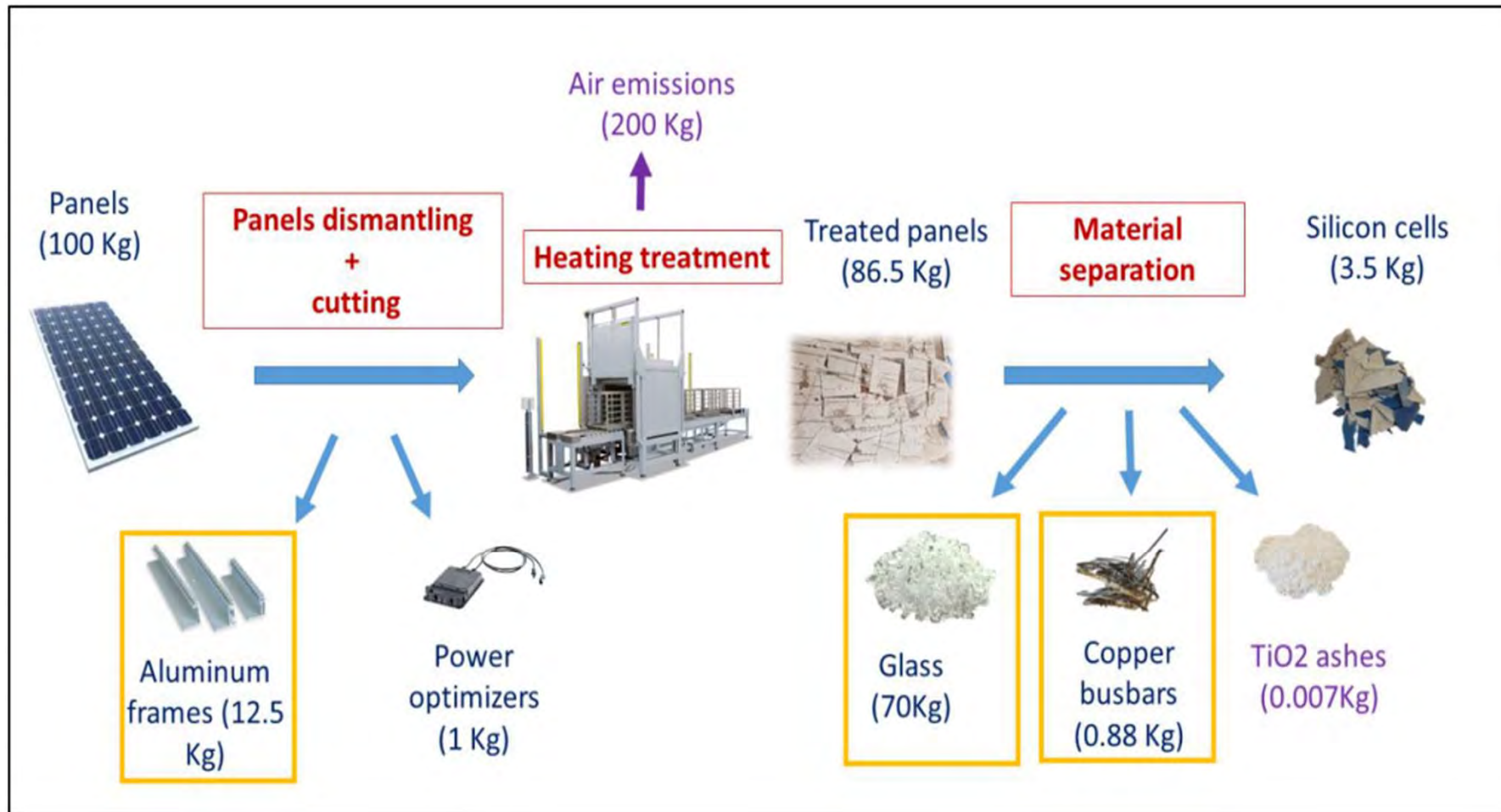


Circular Economy



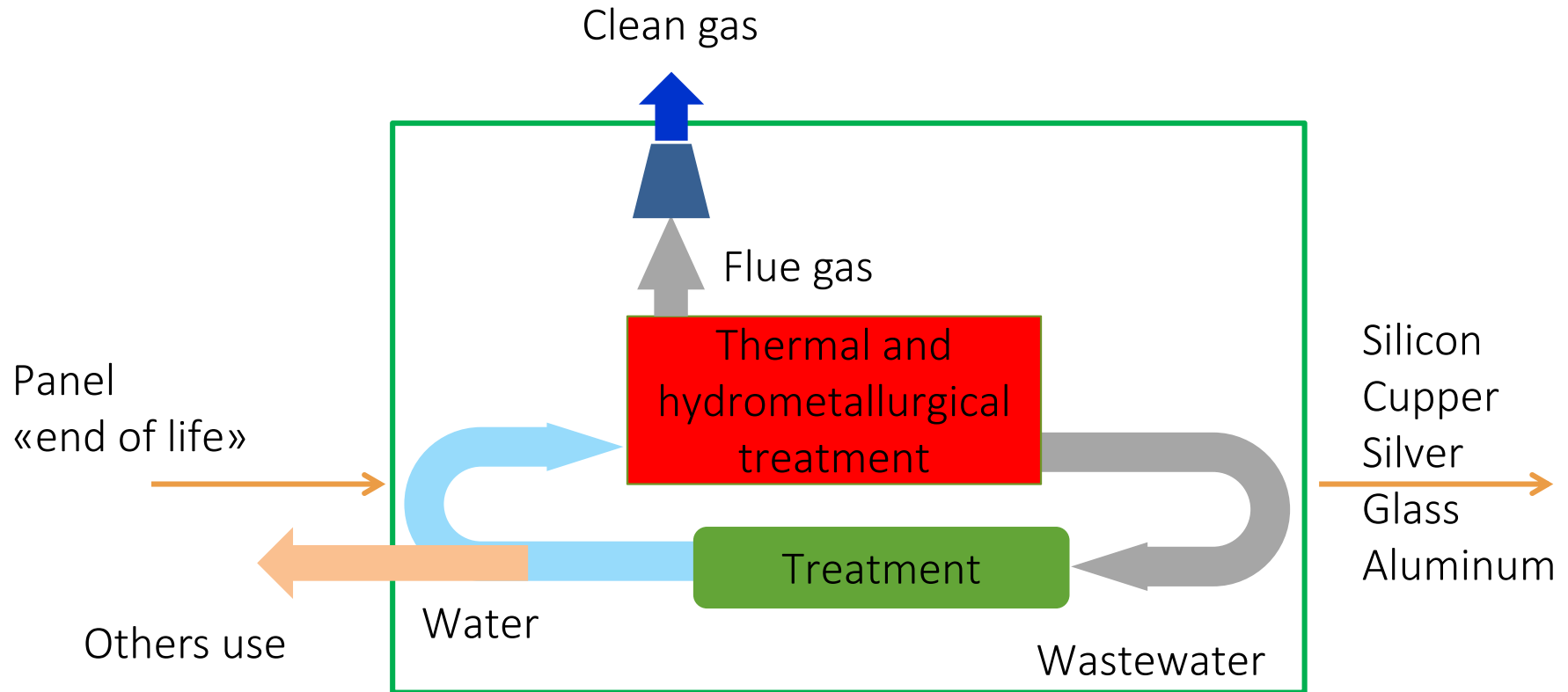
RESIELP: Zero waste plant

Thermal treatment and material separation



Resielp Process

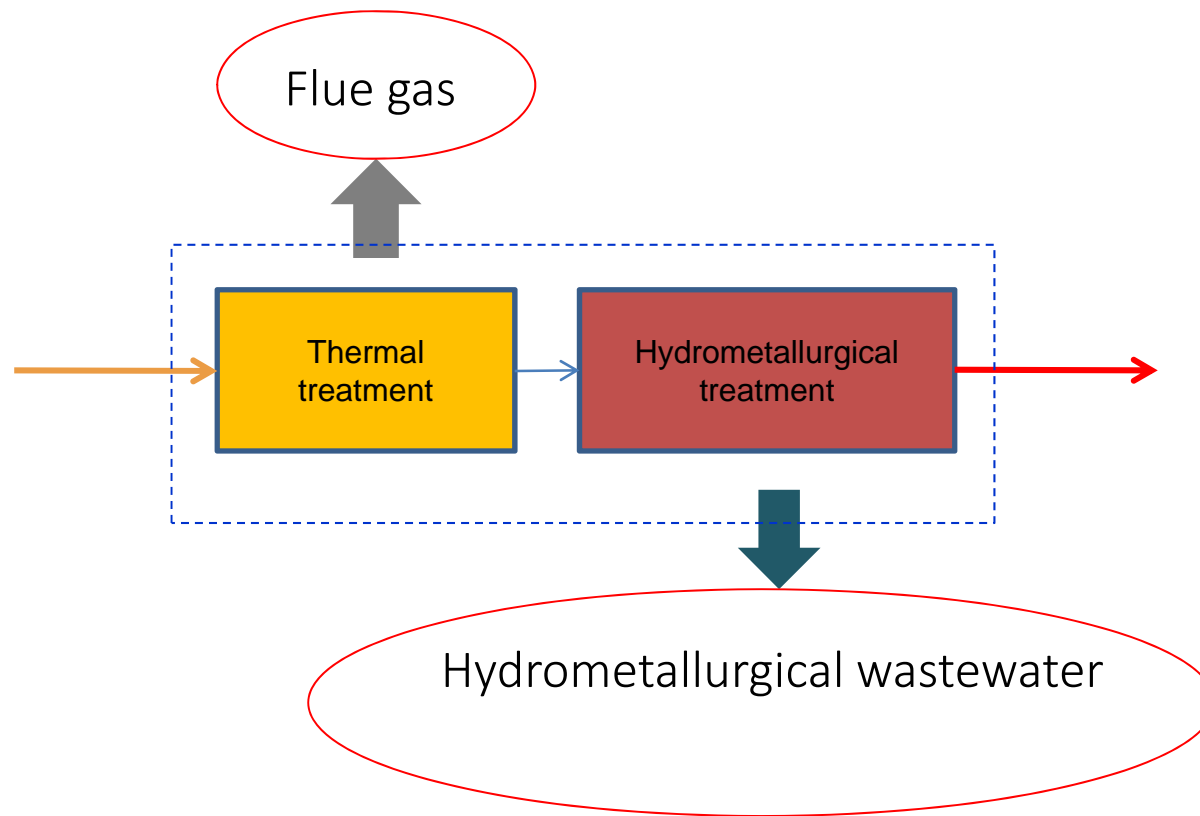
Zero-waste plant



RESIELP. Recovery of Silicon and other materials from End-of-Life Photovoltaic Panels

- 1. Hydrometallurgical wastewater treatment.** ENEA will perform wastewater treatment on hydrometallurgical liquid waste, in laboratory, with consolidated technologies in order to reuse the water into the process.
- 2. Environment assessment.** ENEA will carry out the environmental assessment of every process phase through LCA and LCC methodologies.
- 3. Thermal treatment.** Support to SME for design of plant for thermal treatment (especially for flue gas treatment unit)

Main steps of Process





Separation
machine

Furnace

Recovery Plant installed in Relight:
Separation work station and thermal treatment
part

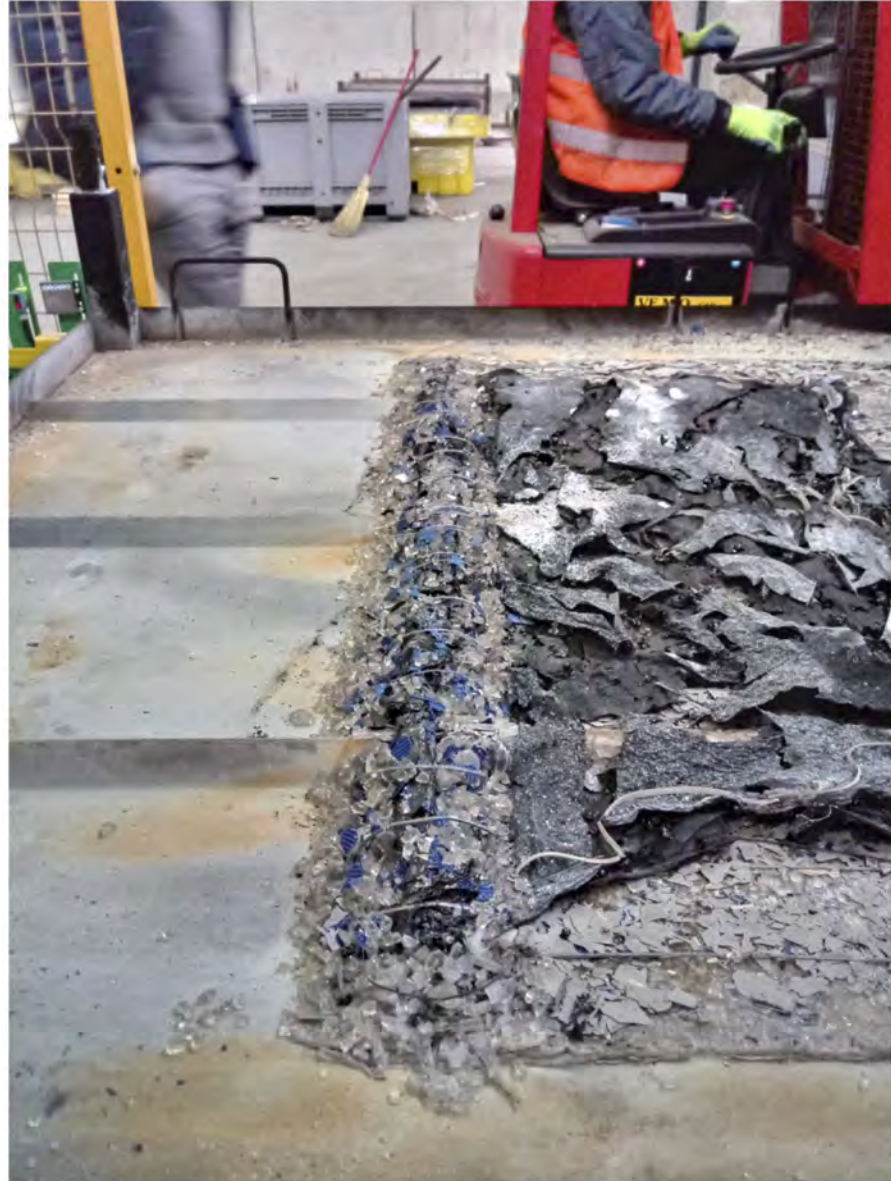


Treatment plant



Before and after thermal treatment



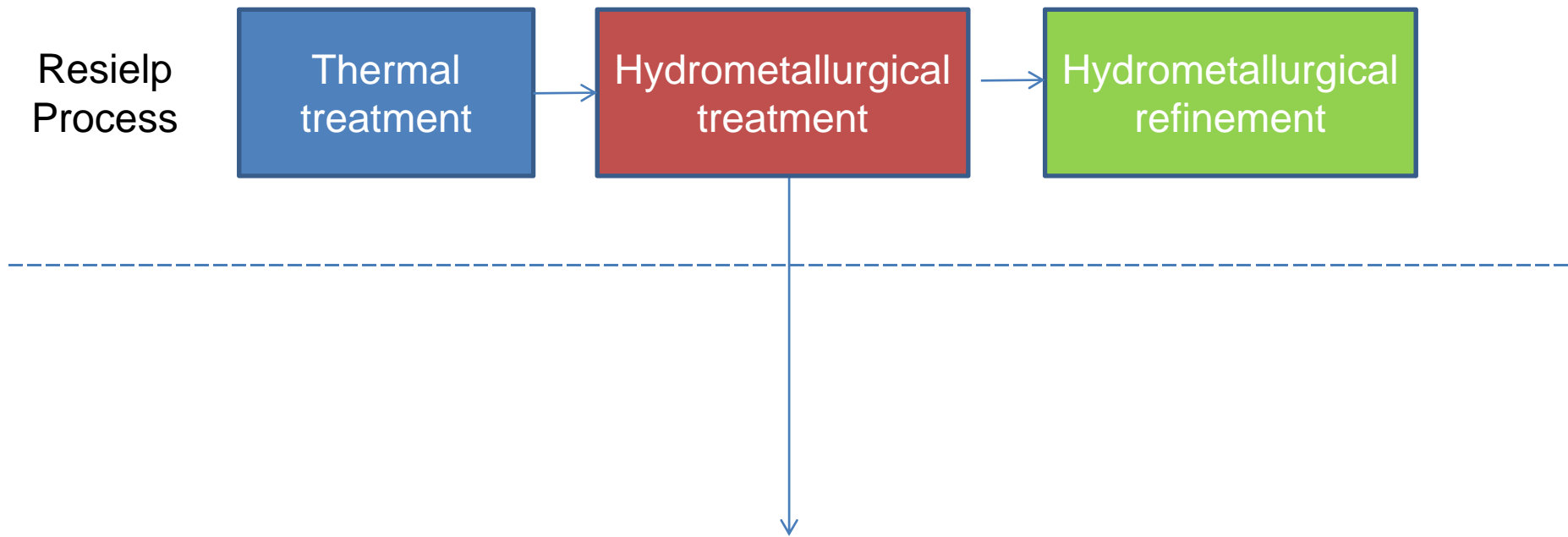


Separation glass-silicon



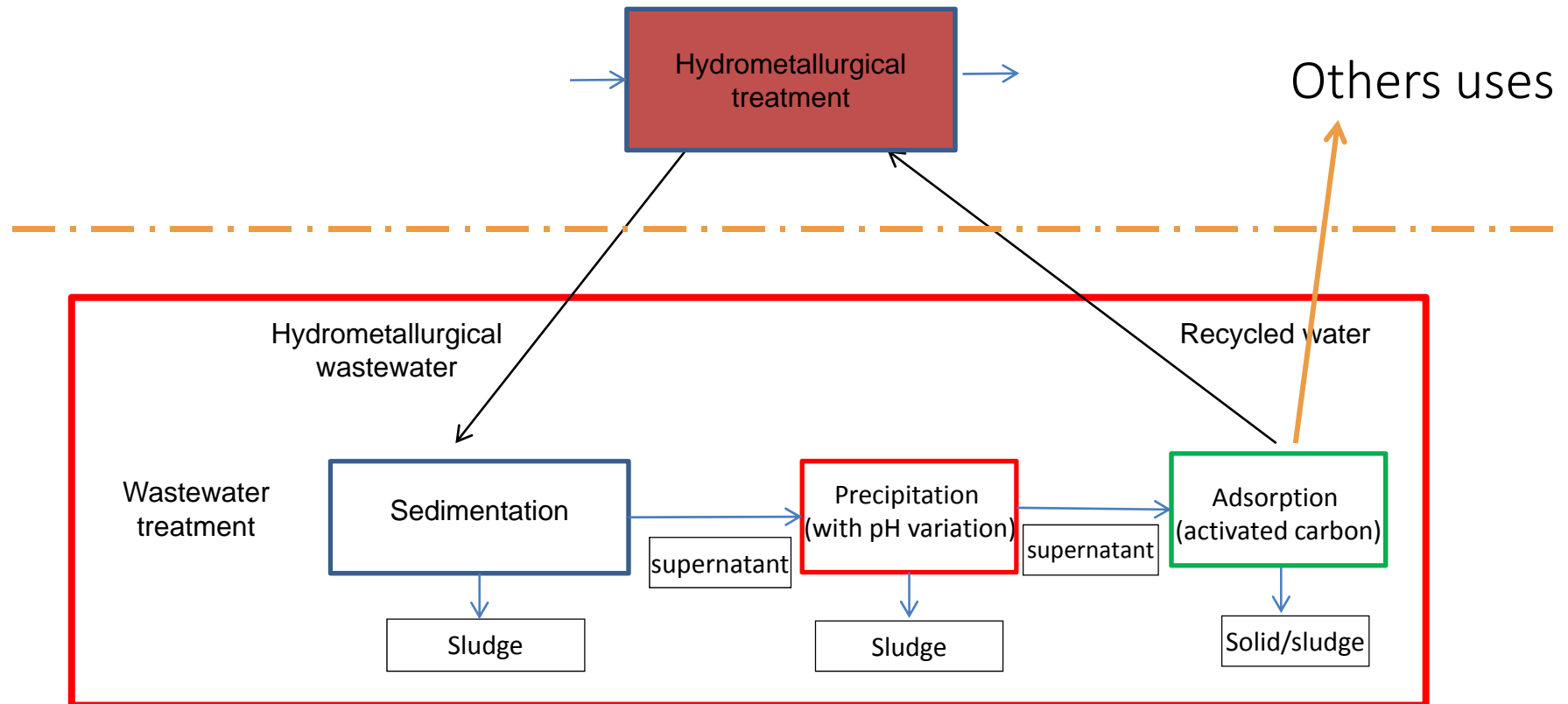
Dopo la separazione, la cella viene sottoposta a trattamento idrometallurgico

Resielp. Hydrometallurgical Wastewater treatment



Wastewater treatment

Second step



Hydrometallurgical wastewater

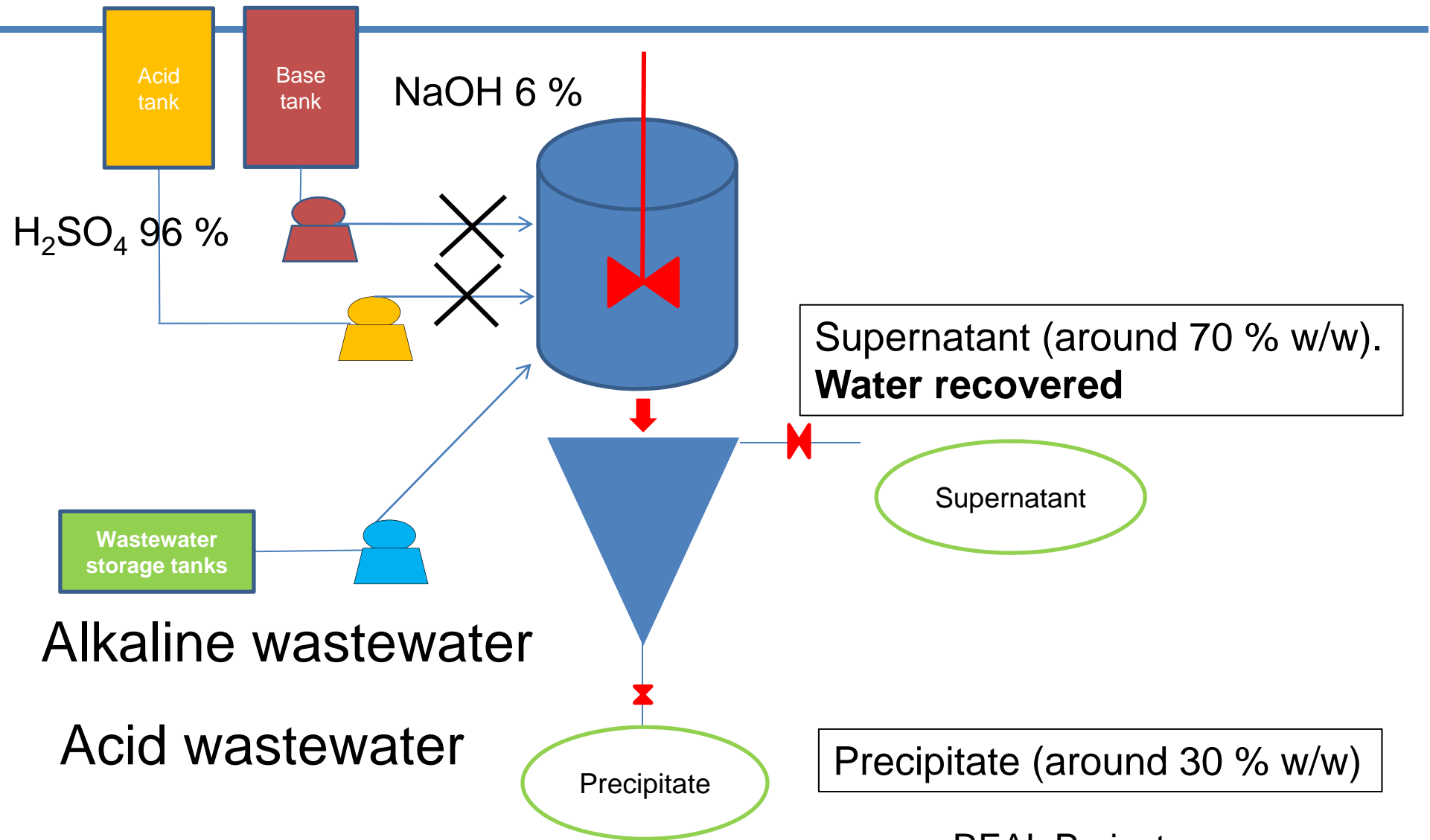
There are two kind of wastewater, based on pH

- ✓ Alkaline
- ✓ Acid

The same removal technologies (sedimentation, precipitation and adsorption on activated carbon) will be tested on these wastewaters.

One purpose is to remove the residual metals.

Flow chart of lab plant wastewater treatment

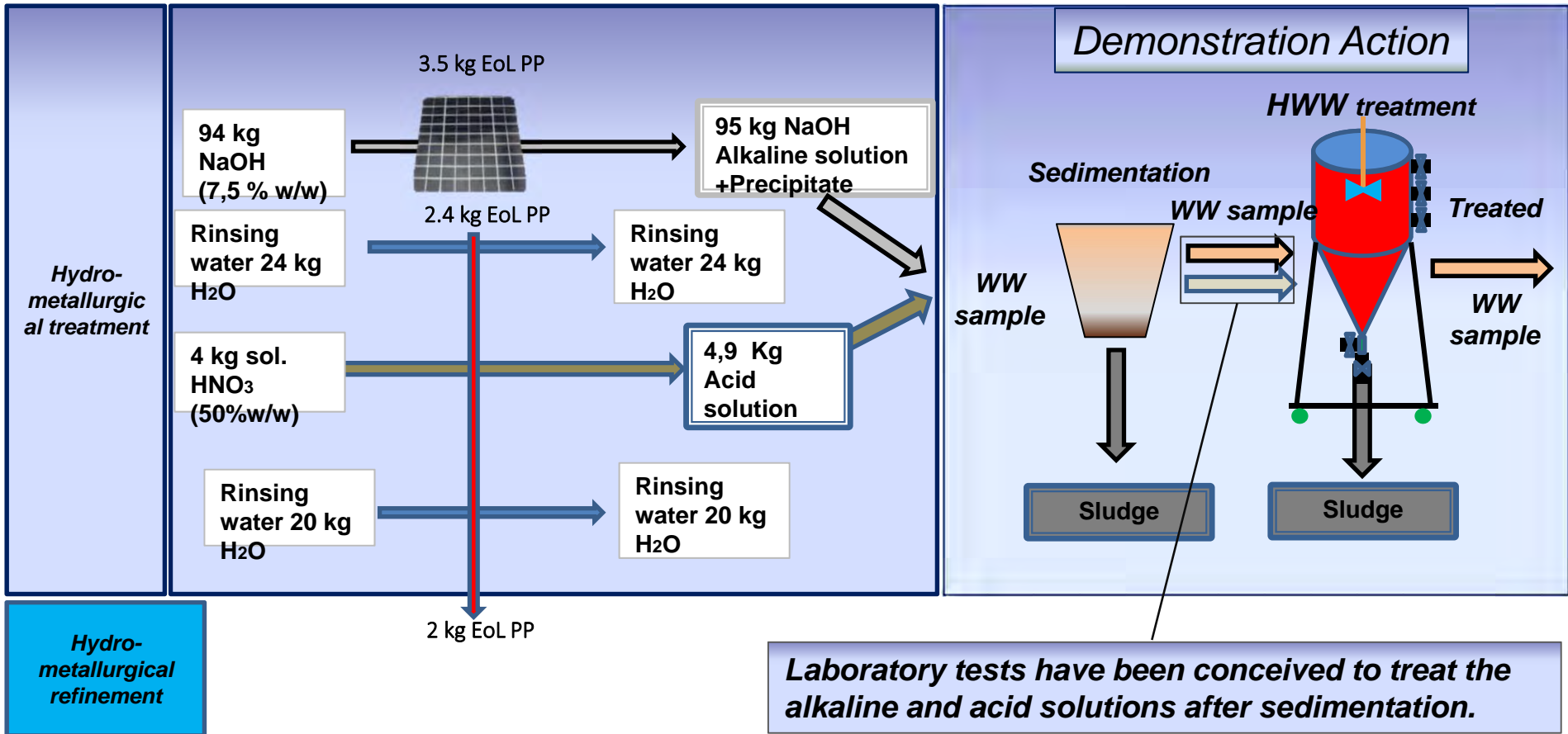


WP[2.4] – Wastewater treatment [ENEA]

600
mm

**Thermal
treatment**

Resielp Process Hydrometallurgical Wastewater flows



Thermal Treatment. Operating condition

- Flue gas composition

Panel composition

Feed air flow (m ³ /h)	320
Duration test (min)	15
Panel composition	
Glass (% wt)	70
Frame (%wt)	15
Tedlar (% wt)	2
EVA (% wt)	7
Other	6

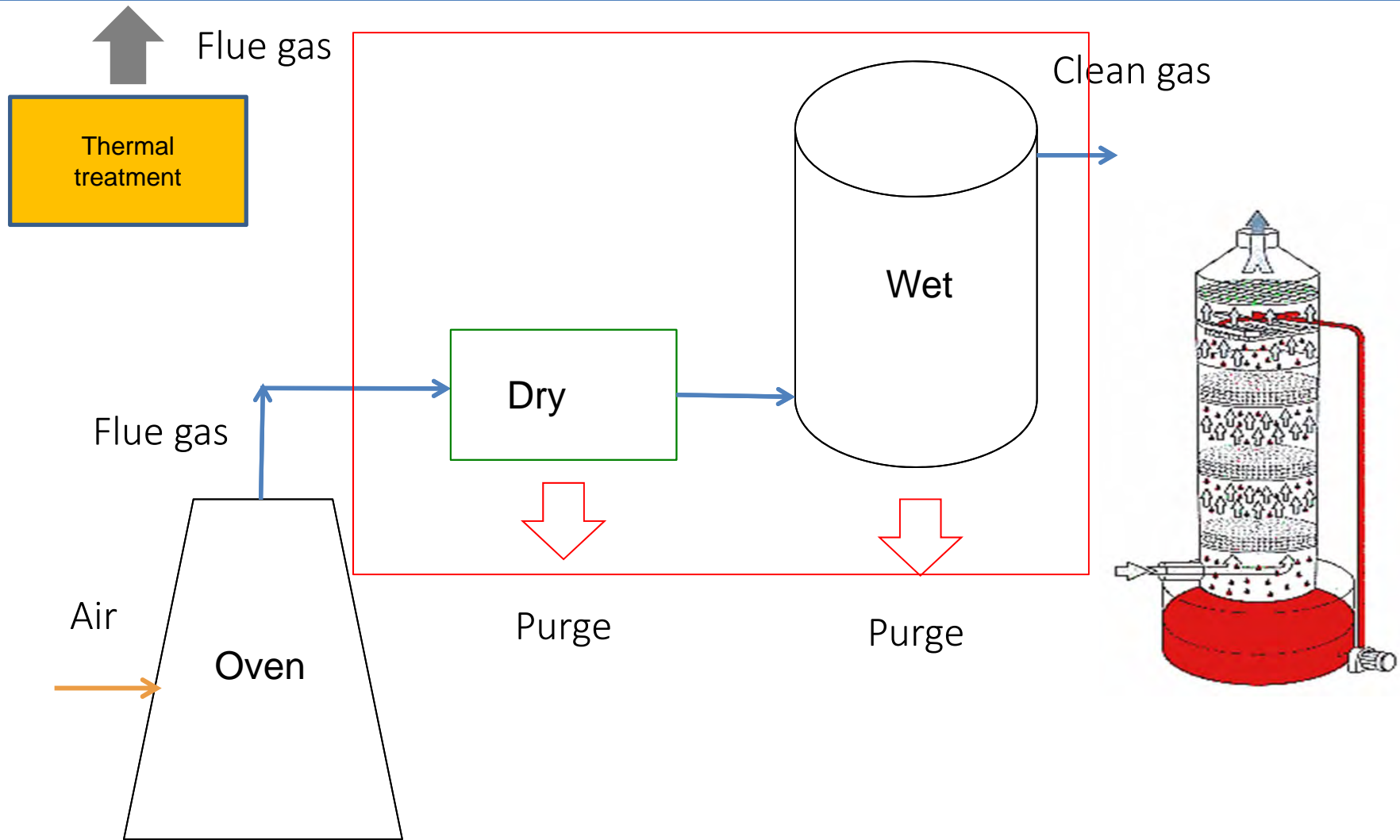
[HF]= 2 (mg/m³)
(calculated)

Metals	Mean concentration (mg/m ³)
Al	1.31E-03
Cr	8.70E-05
Cu	6.08E-05
As	1.34E-05
Cd	5.14E-05
Pb	1.10E-03
Fe	1.76E-04
Sn	3.01E-03
Zn	6.13E-04
In	1.04E-05
Ni	1.37E-05

Estimated from literature*

*Tamaro et al., Renewable Energy 81 (2015) 103-112

Flue gas treatment



ENEA. Italian patent (N. 102017000033488)

“Low energy consumption and low environmental impact method for the recovery of the main components of photovoltaic panels in crystalline silicon at the end of its life“

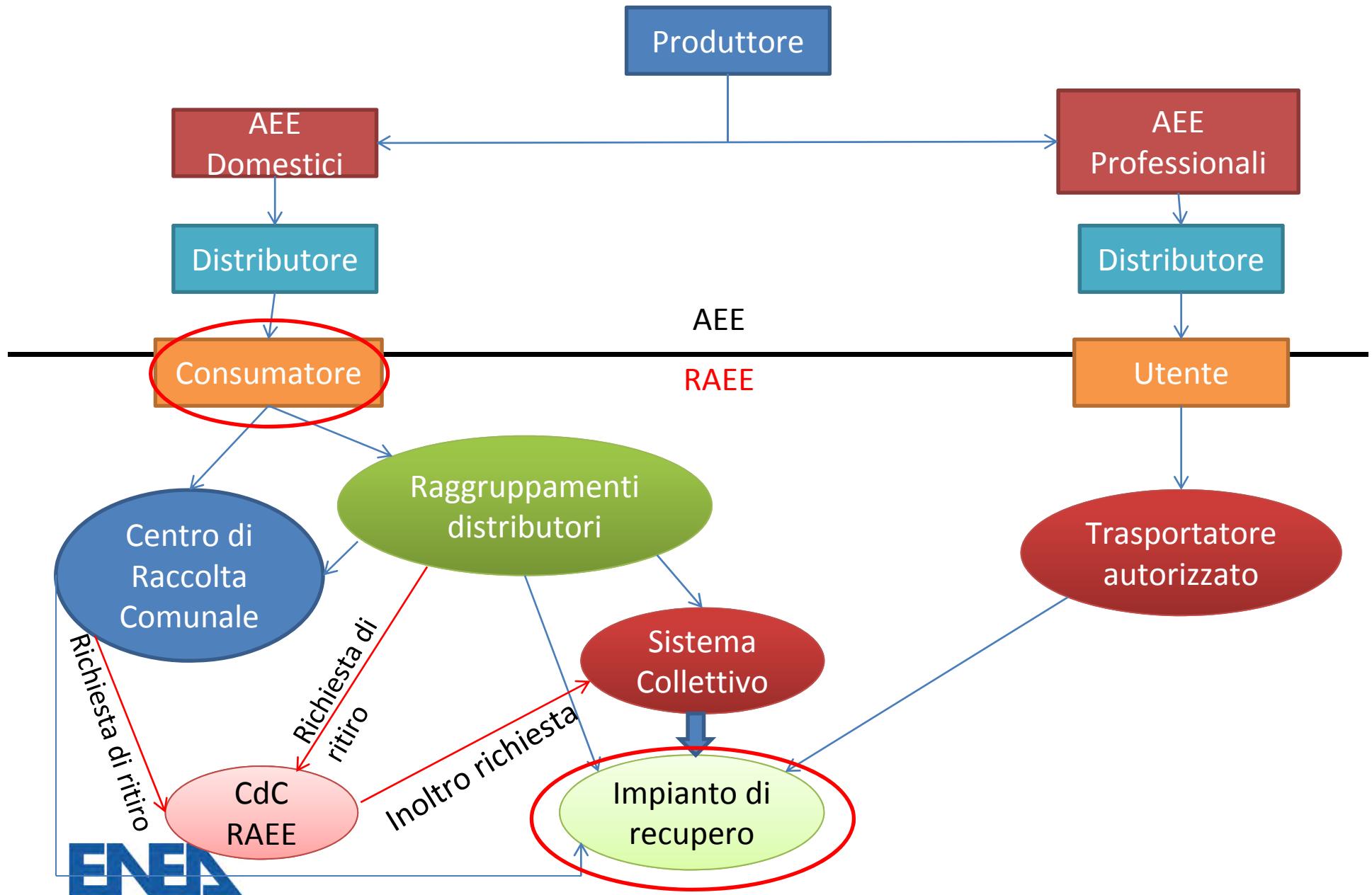
Inventors:

Marco Tammaro (ENEA)

Patrizia Migliaccio (Private society)

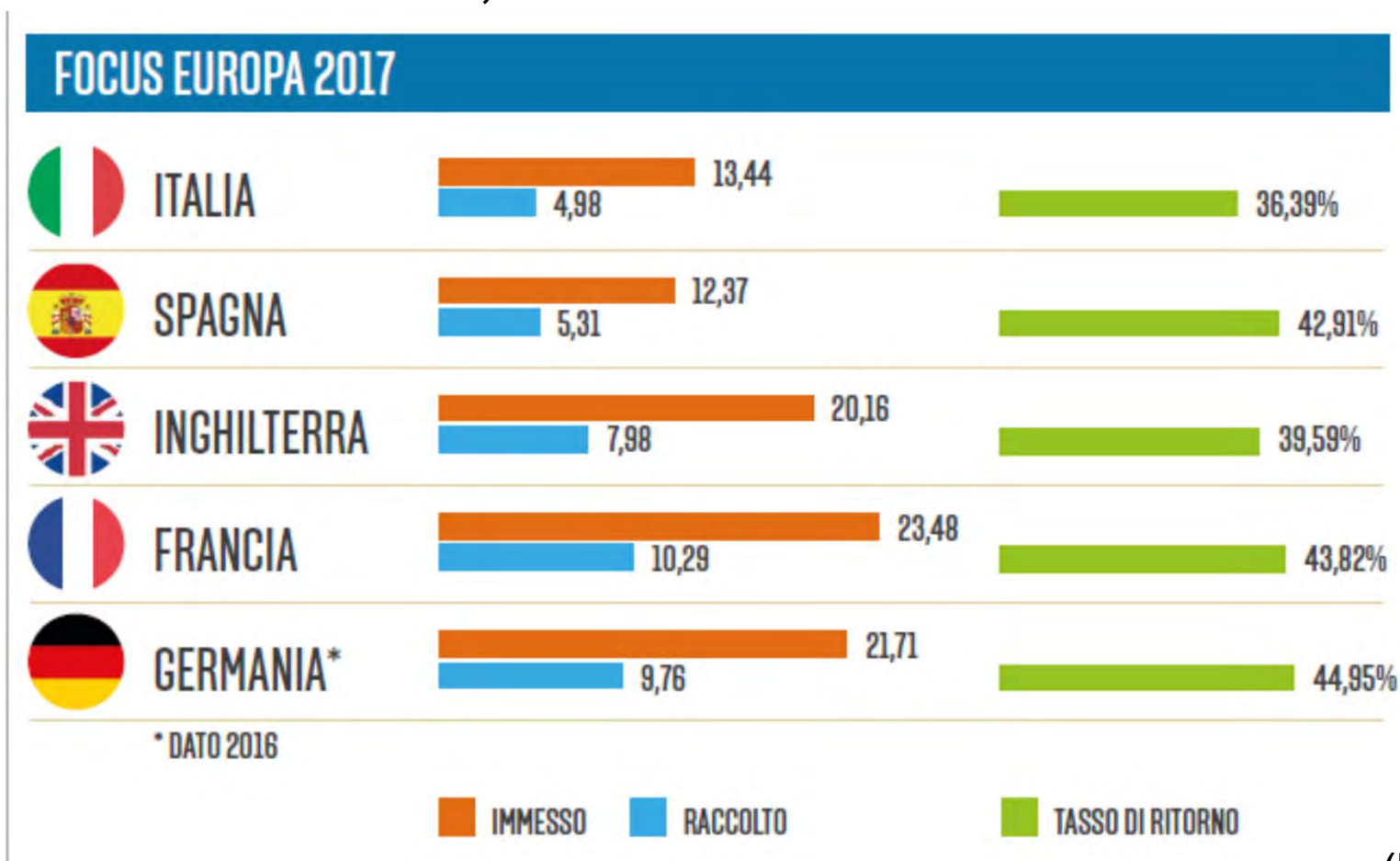
The target was to set a recovery process at low environmental impact.

e - Waste



RAEE in ITALIA e in EUROPA

In Italia nel 2018 raccolte e trattate 310.610 tonnellate di RAEE, di cui circa 80 % domestici



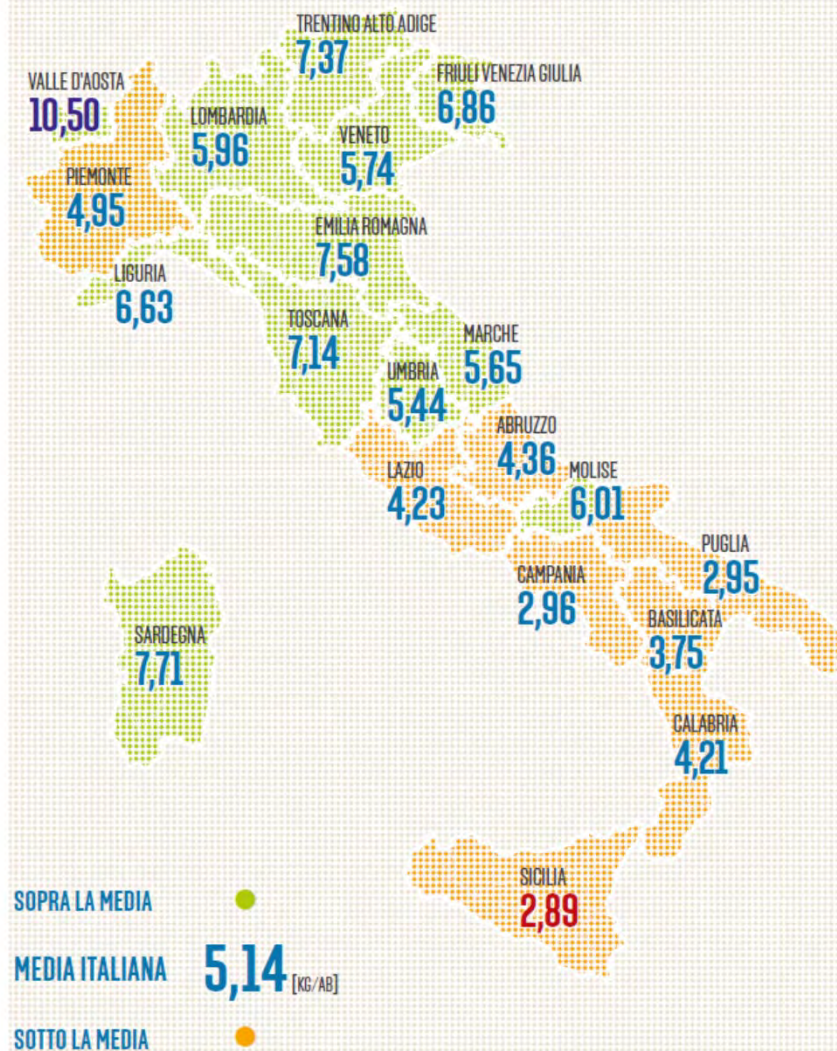
(Kg/abitante)

Immeso: consumo di AEE. Tasso di ritorno: (ton raccolte/ton immesse)



(Fonte: CDC RAEE)

LA RACCOLTA PRO CAPITE DEI RAEI DOMESTICI 2018 [KG/AB]



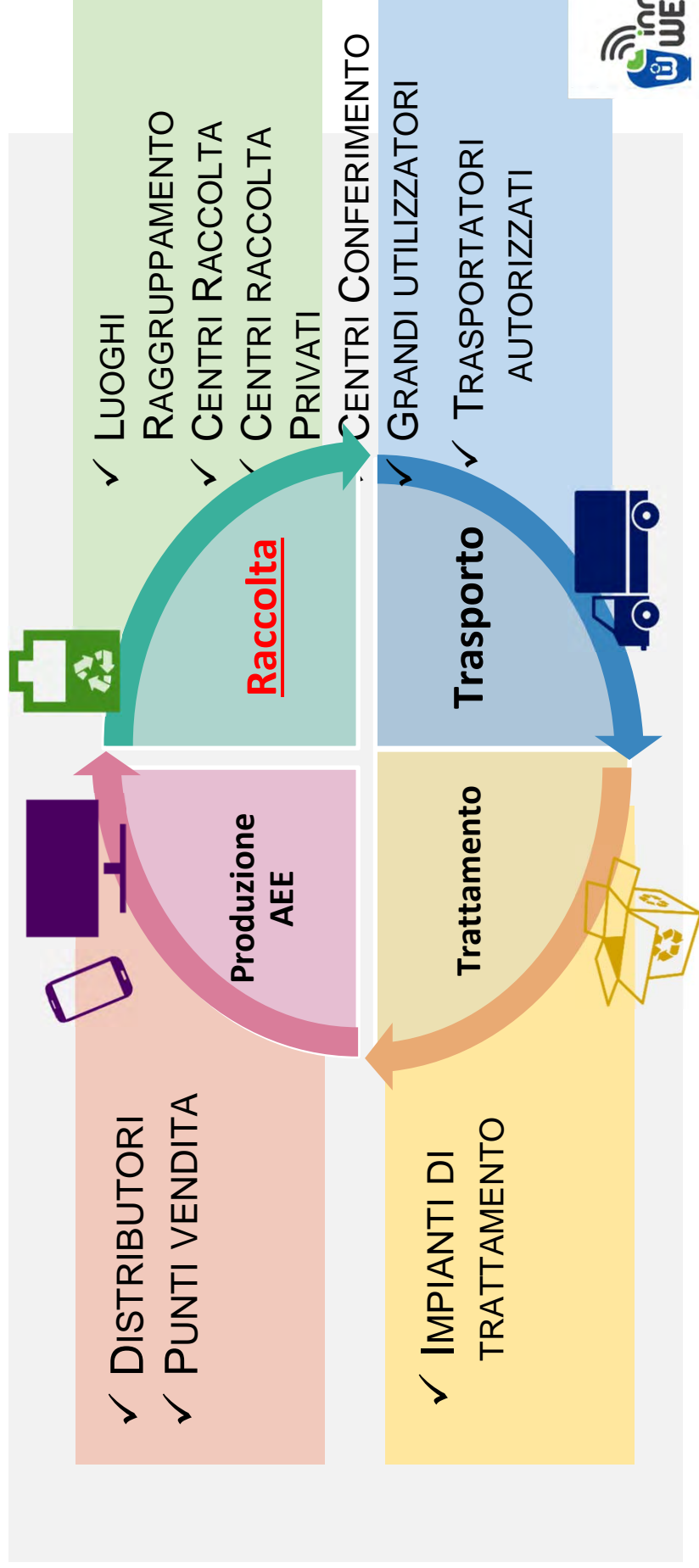
Il SUD sotto la media nazionale

Da questi dati e dalle conclusioni del progetto e-Waste è nata esigenza di un nuovo progetto

INNOWEEE

Innovative WEEE traceability and collection system and geo-interoperability of WEEE data

Progetto finanziato dalla KIC Climate (2018-2021). 2 M€
Sperimentazione sull'applicazione di modelli di Economia Circolare in diverse realtà urbane finalizzata ad aumentare raccolta RAEE ed allungare la vita degli AEE



INNOWEEE

Innovative WEEE traceability and collection system and geo-
interoperability of WEEE data (Inno-WEEE)

Obiettivi del Progetto:

- ✓ Verificare l'applicazione di modelli di economia circolare in una realtà urbana aventi lo scopo di prolungare la vita degli AEE (Apparecchiature Elettriche ed Elettroniche), e di tracciare ed incrementare i flussi di RAEE (Rifiuti da Apparecchiature Elettriche ed Elettroniche).

- Partners:
- ✓ Comune Cava de' Tirreni (SA),
 - ✓ ENEA Trento e Bath (UK)
 - ✓ Dedagroup ✓ Metellia Servizi
 - ✓ Ecodom ✓ Fondazione Bruno Kessler

Durata: 3 anni

Start: 01/07/2018

End: 30/06/2021

Total funding: 2.002.184 €

Soggetto Finanziatore

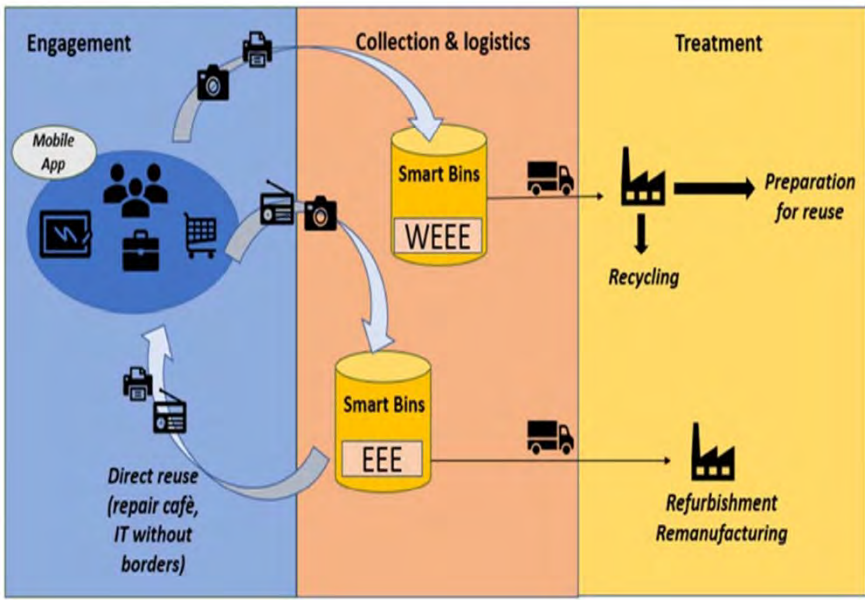
- ✓ EIT Climate-KIC. Bando Demonstrator



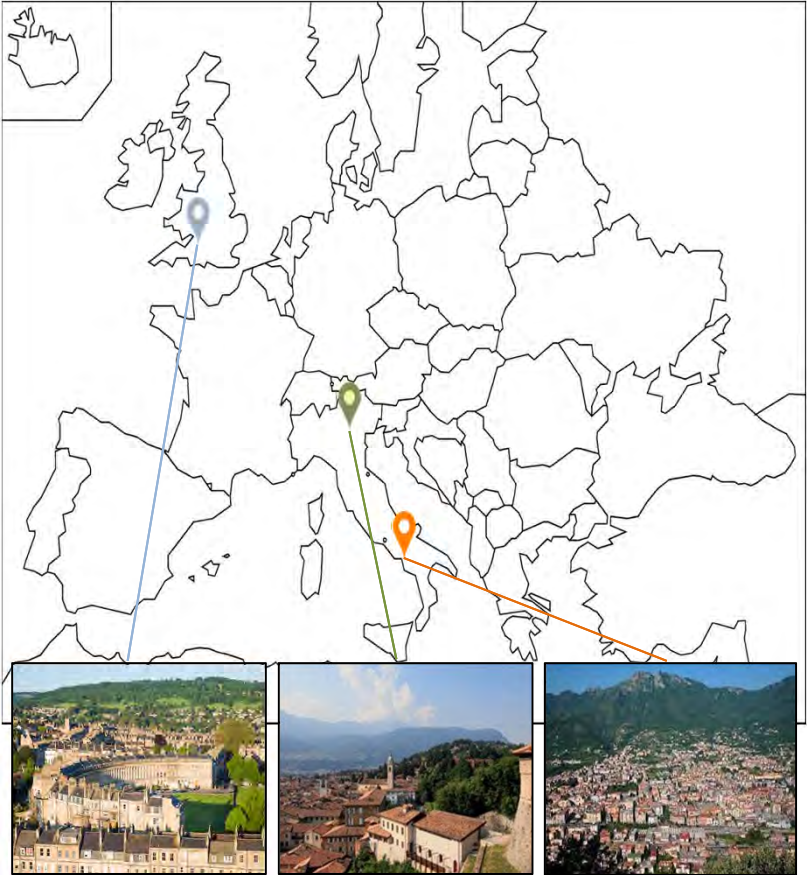
InnoWEEE project – a logic overview



InnoWEEE data platform Data collection and analysis



Three pilot campaigns



BathNES

Rovereto

Cava de' Tirreni



The InnoWEEE project


Innovative WEEE traceability and collection system and geo-interoperability of WEEE data

Smart collection and processing solutions for
E-WASTE



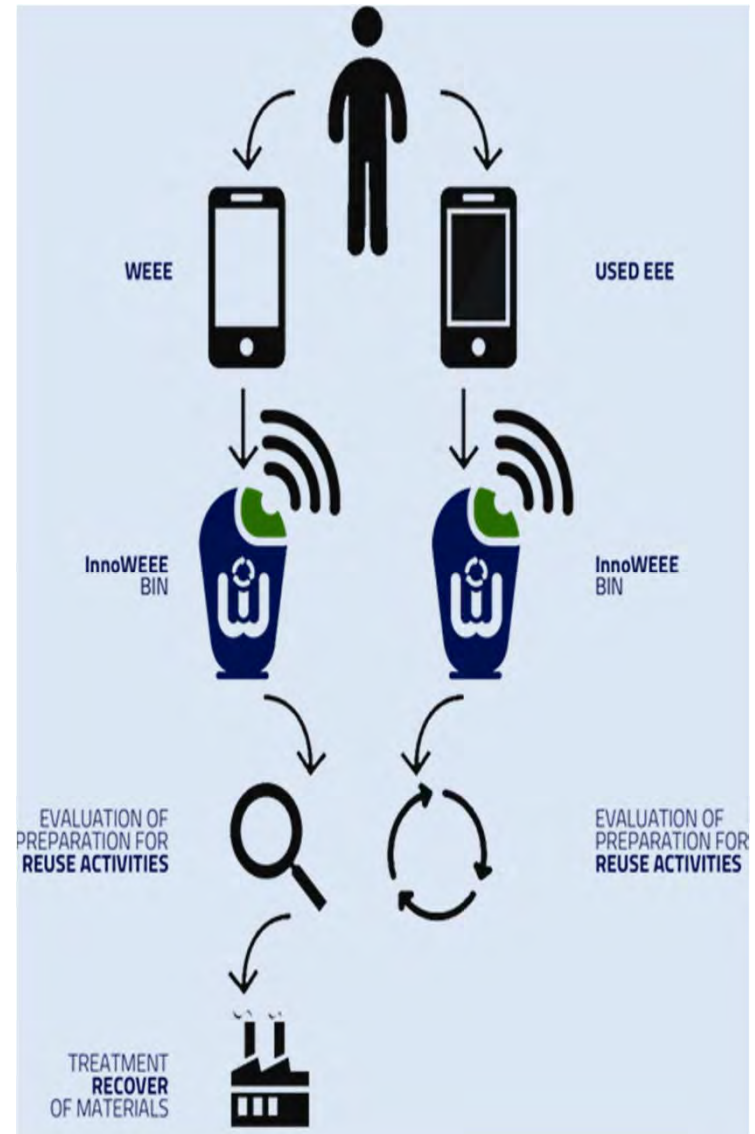
Supported by:



Climate-KIC is supported by the EIT, a body of the European Union 



www.innoweee.eu



The background

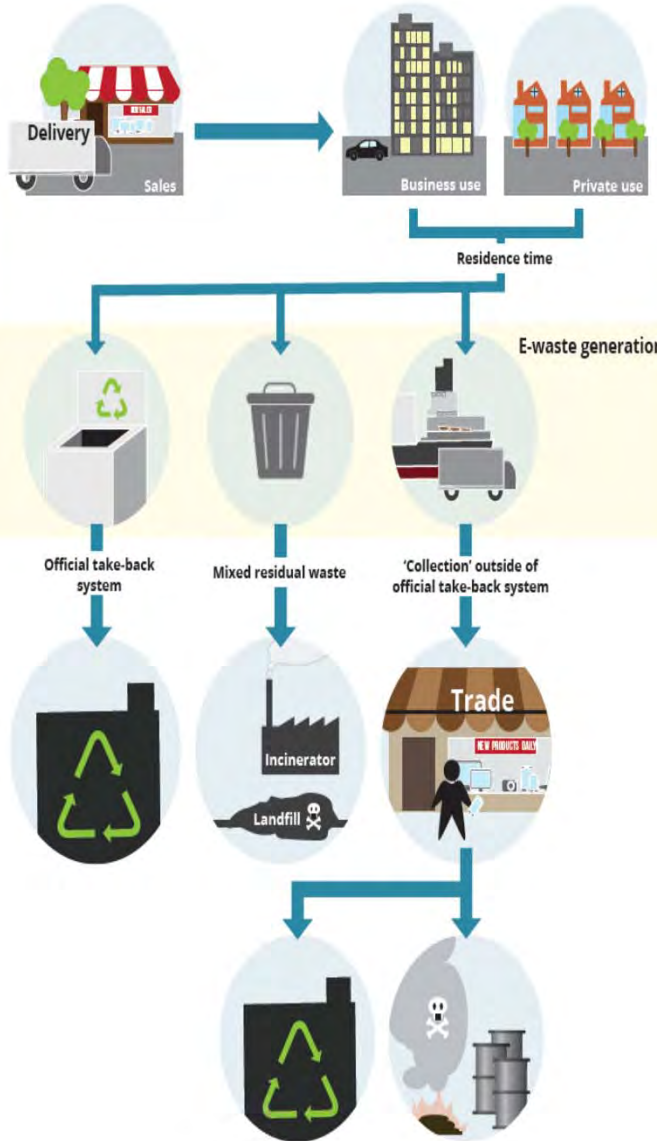


E-WASTE

- the fastest growing domestic waste stream in the world
- the amount of *e-waste* grew by 8% between 2014 and 2016
- 76% of *e-waste* generated is not properly disposed

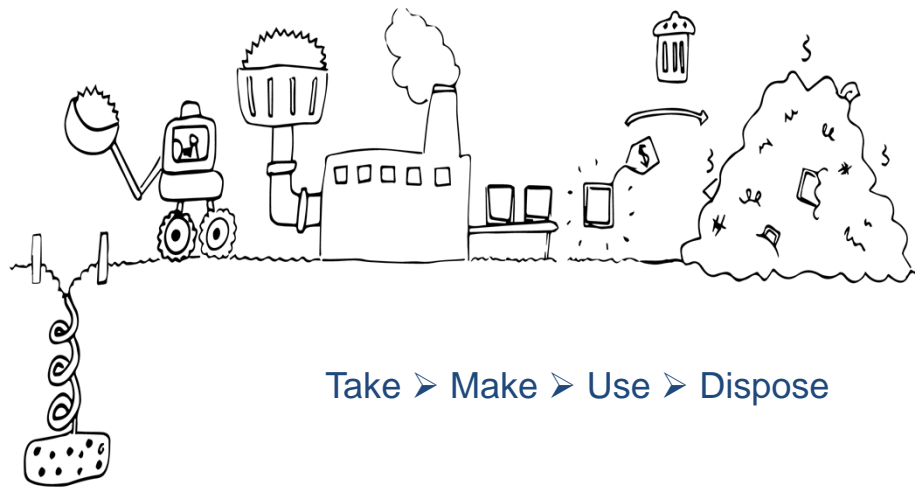


The background



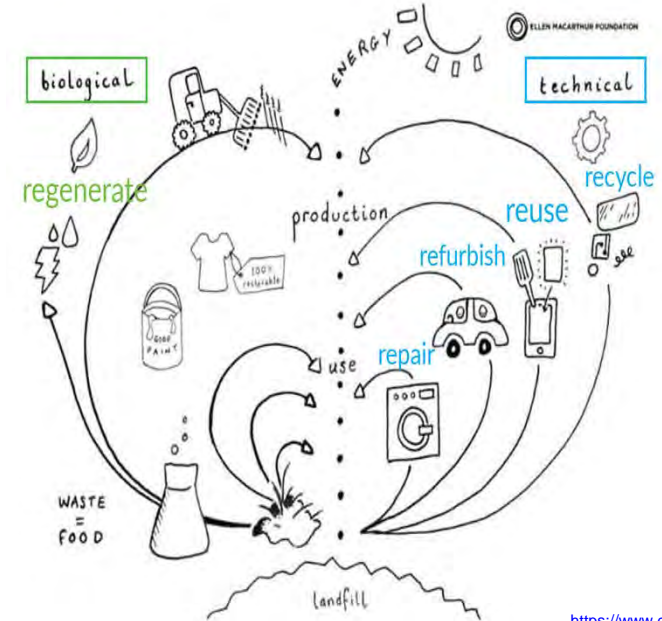
The challenge

From linear economy...



From waste to resources

How may we reuse our waste?
recycle
refurbish
reuse
repair
regenerate
re...

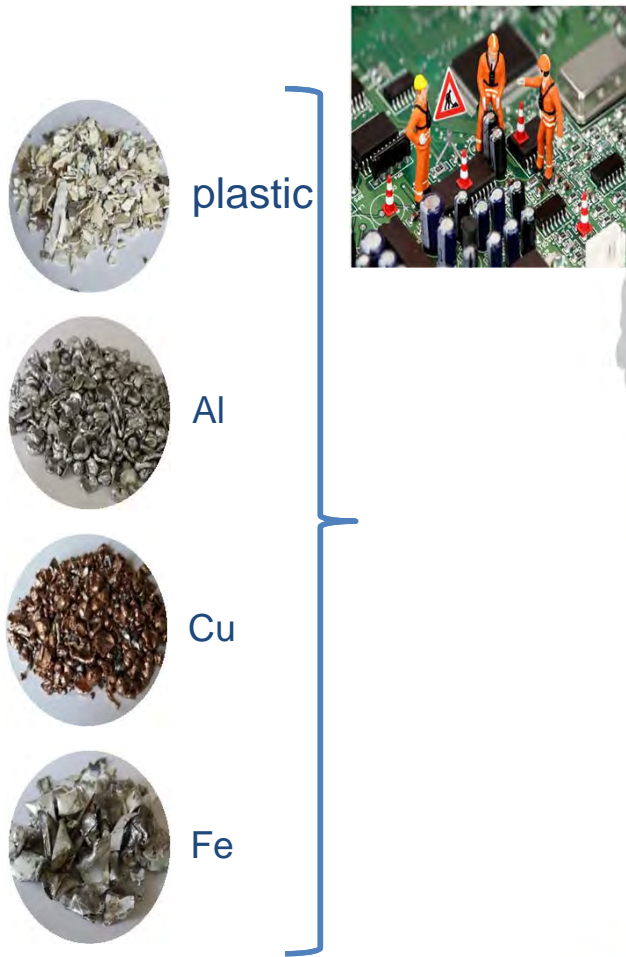


<https://www.dezeen.com>

...to circular economy

Think circular

Treatment and recovery of valuable fractions



Securing of hazardous substances



CFCs and HCFCs

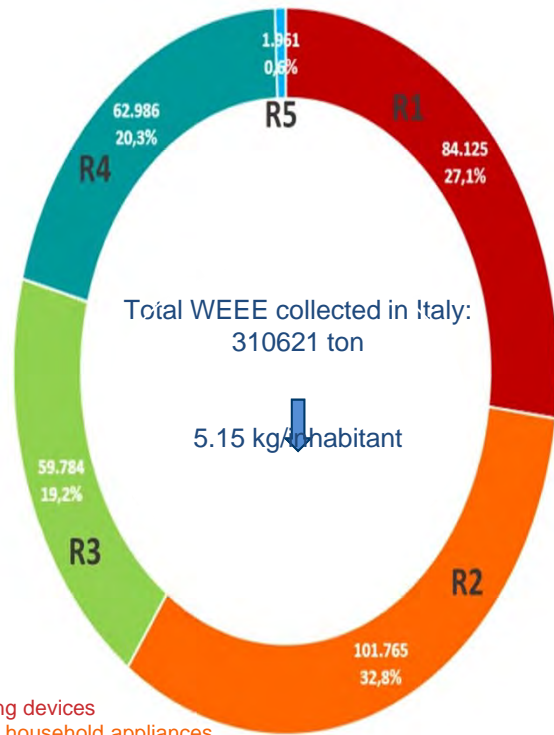
BFRs

PCBs

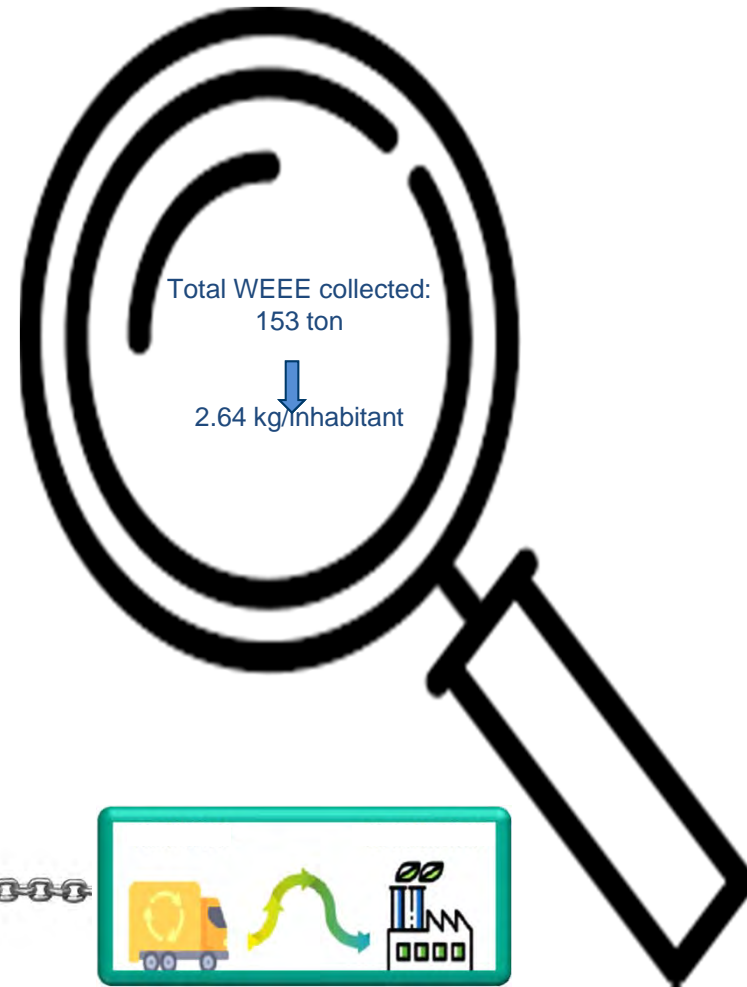
Pb, Cd, Hg, Cr⁶⁺

InnoWEEE project – the Cava de' Tirreni pilot

...while in Cava de' Tirreni



- R1: Cooling devices
- R2: Large household appliances
- R3: Devices with a display screen
- R4: Small household appliances
- R5: Lamps



InnoWEEE project – the Cava de' Tirreni pilot for WEEE

WHAT?

- Small household appliances
- IT and telecommunications
- Electrical and electronic tools
- Toys, leisure & sport equipment
- Consumer electronics

WHEN?

From October 2019
to June 2021

WHO?

The whole citizenship

WHERE?

1. Three high schools
2. City Hall
3. Mall
4. Historical centre

HOW?

1. Information and sensibilization activities
2. Rewarding systems (both intrinsic and extrinsic)



Brochure di progetto. Pilota di Cava de' Tirreni

La sperimentazione di Cava de' Tirreni: tutta la città *raccoglie* la sfida

Questa sperimentazione si pone l'obiettivo di incentivare l'adozione di comportamenti più ecosostenibili, aumentando la consapevolezza dei cittadini rispetto allo smaltimento corretto dei RAEE e alla possibilità di prolungare la vita degli AEE.

DOVE?

Nell'intera città di Cava de' Tirreni, in punti strategici del territorio come scuole, supermercati e luoghi pubblici.

PER CHI?

L'intera popolazione (quasi 53.000 abitanti), coinvolgendo famiglie e comunità scolastiche.

COME?

RAEE ed AEE saranno raccolti separatamente, i primi attraverso un sistema di contenitori intelligenti, i secondi attraverso un sistema di recupero per il loro riutilizzo. I contenitori saranno dotati di un sistema di riconoscimento degli utenti che permetterà di fornire

www.ecodom-consorzio.it

Un nuovo modello di
Economia Circolare
applicato alla città

03

informazioni ambientali relative al conferimento e di attuare un meccanismo d'incentivazione, studiato in funzione delle caratteristiche degli utenti e delle disponibilità locali.

QUANDO?

Il progetto è iniziato nel 2018 e terminerà nel 2021. La sperimentazione durerà 18 mesi.

CHI?

L'ENEA coordinerà le attività. I partner principali della sperimentazione saranno l'Amministrazione Comunale, Metellia Servizi S.r.l. ed ECODOM.

Comunicazione Rewarding system



Supported by:



Climate-KIC is supported by the ETC body of the European Union

WEEE (R4)

	Plastica	Vetro	Ferro	Alluminio	Rame	Stagno	Nickel	Argento	Oro	PGMs - Platino	Altre frazioni
Apparecchiature di consumo	36.42%	0.04%	33.90%	12.14%	6.74%	0.57%	0.03%	0.01%	0.001%	0.0004%	10.15%
Giocattoli e apparecchiature per il tempo libero e per lo sport	69.82%	0.06%	9.99%	1.86%	2.13%	0.27%	0.01%	0.003%	0.001%	0.0002%	15.86%
Apparecchiature informatiche e per telecomunicazioni	27.53%	0.32%	42.31%	19.81%	8.92%	0.48%	0.04%	0.01%	0.002%	0.0010%	0.58%
Piccoli elettrodomestici	36.68%	0.00%	40.31%	14.01%	6.92%	0.03%	0.01%	0.00%	0.000%	0.0001%	2.04%
Strumenti elettrici ed elettronici	48.03%	0.00%	29.14%	9.01%	4.90%	0.00%	0.00%	0.00%	0.00%	0.0000%	8.92%

(PGM) Metalli del gruppo del platino è il nome collettivo per i sei metalli rutenio, rodio, palladio, osmio, iridio e platino, che occupano posizioni contigue nella tavola periodica degli elementi, nei gruppi 8, 9 e 10. I metalli del gruppo del platino sono tutti rari e costosi, hanno proprietà fisiche e chimiche simili, e tendono a presentarsi insieme negli stessi giacimenti minerari

WEEE. IT material

Oggetto raccolto	Peso medio [kg]
Stampanti	6.26
Computer (componenti)	1.04
Personal computer	10.37
Mouse	0.09
Tastiera	1.07
Scanner	2.52
Telefoni senza filo	0.11
Tablet	0.33
Telefono fisso	0.73
Modem	0.41
Laptop	1.93
Copiatrice	2.92
Notebook	1.93
Calcolatrici tascabili e da tavolo	0.08
Telefono cellulare	0.14
Smartphone	0.10
Telecomando	0.08
Chiavetta USB	0.06
Router	0.41
Decoder	2.50
Apparecchiature di navigazione GPS	0.22
E-reader	0.19
Monitor	4.35
Altre apparecchiature informatiche per telecomunicazi	1.65

WEEE composition


Oggetto raccolto	Materiali recuperabili [g]									
	Vetro	Ferro	Alluminio	Rame	Stagno	Nickel	Argento	Oro	PGMs - Platino	Altre frazioni
Stampanti	20.03	2648.61	1240.11	558.39	30.05	2.50	0.38	0.13	0.06	36.37
Computer (componenti)	3.32	438.75	205.43	92.50	4.98	0.41	0.06	0.02	0.01	6.02
Personal computer	33.18	4387.55	2054.30	925.00	49.78	4.15	0.62	0.21	0.10	60.25
Mouse	0.29	38.08	17.83	8.03	0.43	0.04	0.01	0.00	0.00	0.52
Tastiera	3.42	452.72	211.97	95.44	5.14	0.43	0.06	0.02	0.01	6.22
Scanner	8.06	1066.21	499.21	224.78	12.10	1.01	0.15	0.05	0.03	14.64
Telefoni senza filo	0.35	46.54	21.79	9.81	0.53	0.04	0.01	0.00	0.00	0.64
Tablet	1.06	139.62	65.37	29.44	1.58	0.13	0.02	0.01	0.00	1.92
Telefono fisso	2.34	308.86	144.61	65.12	3.50	0.29	0.04	0.01	0.01	4.24
Modem	1.31	173.47	81.22	36.57	1.97	0.16	0.02	0.01	0.00	2.38
Laptop	6.18	816.58	382.33	172.16	9.26	0.77	0.12	0.04	0.02	11.21
Copiatrice	9.34	1235.45	578.45	260.46	14.02	1.17	0.18	0.06	0.03	16.97
Notebook	6.18	816.58	382.33	172.16	9.26	0.77	0.12	0.04	0.02	11.21
Calcolatrici tascabili e da tavolo	0.26	33.85	15.85	7.14	0.38	0.03	0.00	0.00	0.00	0.46
Telefono cellulare	0.45	59.23	27.73	12.49	0.67	0.06	0.01	0.00	0.00	0.81
Smartphone	0.32	42.31	19.81	8.92	0.48	0.04	0.01	0.00	0.00	0.58
Telecomando	0.26	33.85	15.85	7.14	0.38	0.03	0.00	0.00	0.00	0.46
Chiavetta USB	0.19	25.39	11.89	5.35	0.29	0.02	0.00	0.00	0.00	0.35
Router	1.31	173.47	81.22	36.57	1.97	0.16	0.02	0.01	0.00	2.38
Decoder	8.00	1057.75	495.25	223.00	12.00	1.00	0.15	0.05	0.03	14.53
Apparecchiature di navigazione GPS	0.70	93.08	43.58	19.62	1.06	0.09	0.01	0.00	0.00	1.28
E-reader	0.61	80.39	37.64	16.95	0.91	0.08	0.01	0.00	0.00	1.10
Monitor	13.92	1840.49	861.74	388.02	20.88	1.74	0.26	0.09	0.04	25.27
Altre apparecchiature informatiche per telecomunicazioni	5.26	696.04	325.89	146.74	7.90	0.66	0.10	0.03	0.02	9.56

SCENARIOS



Supported by:



Climate-KIC is supported by the
EIT, a body of the European Union 

Scenarios comparison

		tCO ₂ eq PRODOTTE		
		Scenario InnoWEEE tCO ₂ eq	Scenario Discarica tCO ₂ eq	Scenario CASSETTO tCO ₂ eq
1,000 tons	Mixed WEEE			
	TOT	1,203	3,471	2,309
	1 TRANSPORT FROM CITIZENS HOUSES TO COLLECTION POINTS	0		
	1 TRANSPORT FROM COLLECTION POINTS TO TREATMENT PLANTS/LANDFILL	536	536	
	3 TREATMENT	39		
	4 TRANSPORTS AFTER TREATMENT	91		
	5 RECOVERY, RECYCLING AND LANDFILL DISPOSAL	537	627	
	6 PRODUCTION OF EQUIVALENT PRODUCTS	0	2,309	

tCO₂ eq EVITATE

Beneficio (CASSETTO - InnoWEEE)
tCO ₂ eq
1,105

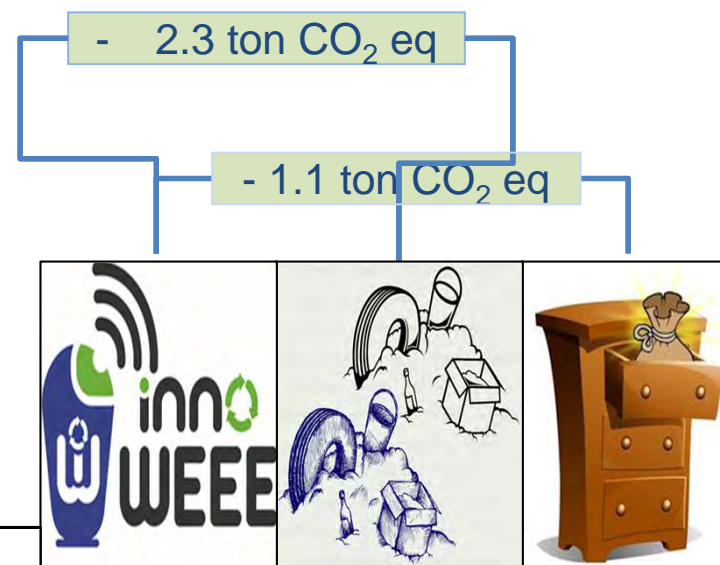
Beneficio (Discarica - INNOWEEE)
tCO ₂ eq
2,268

Fonte: Ecodom



InnoWEEE project – avoided CO₂

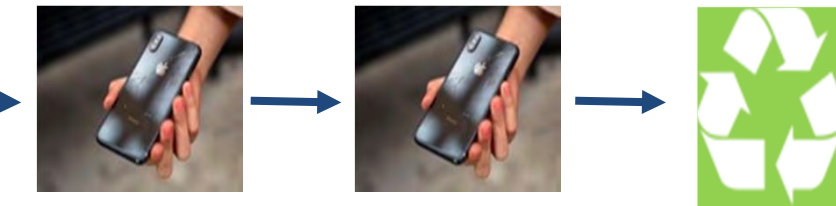
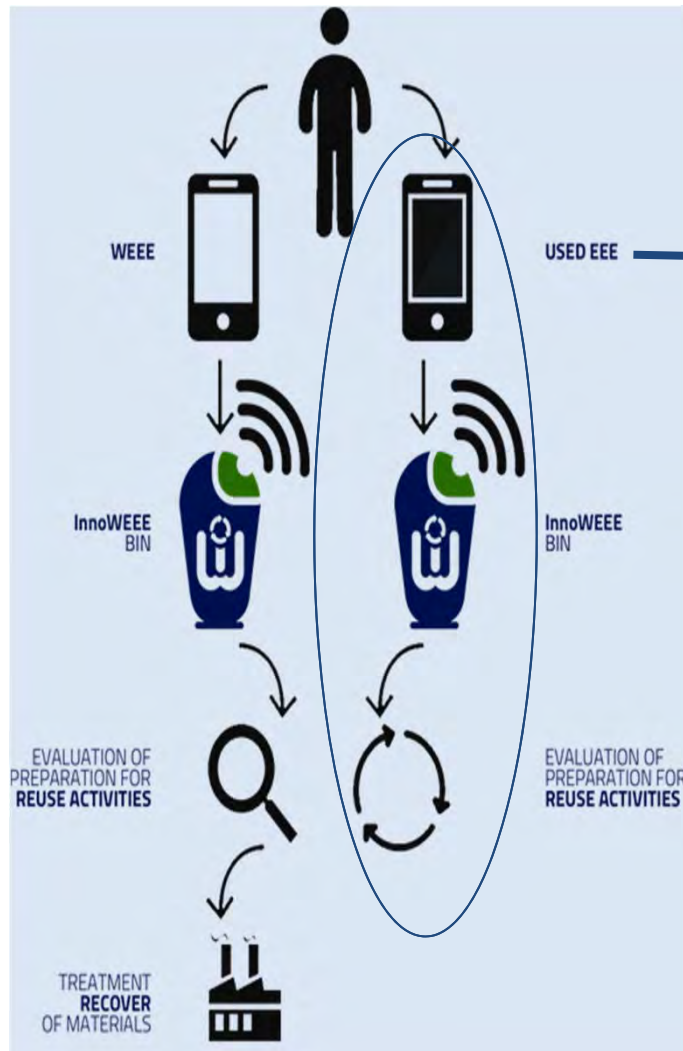
	Average avoided emissions
Small household appliances	1.8 kg CO ₂ eq
IT and telecommunications	1.8 kg CO ₂ eq
Electrical and electronic tools	2.5 kg CO ₂ eq
Toys, leisure & sport equipment	0.7 kg CO ₂ eq
Consumer electronics	1.3 kg CO ₂ eq



Mixed WEEE				
1,000	tons	tCO ₂ eq	tCO ₂ eq	tCO ₂ eq
TOT		1,203	3,471	2,309
1	TRANSPORT FROM CITIZENS HOUSES TO COLLECTION POINTS	0		
1	TRANSPORT FROM COLLECTION POINTS TO TREATMENT PLANTS/LANDFILL	536	536	
3	TREATMENT	39		
4	TRANSPORTS AFTER TREATMENT	91		
5	RECOVERY, RECYCLING AND LANDFILL DISPOSAL	537	627	
6	PRODUCTION OF EQUIVALENT PRODUCTS	0	2,309	

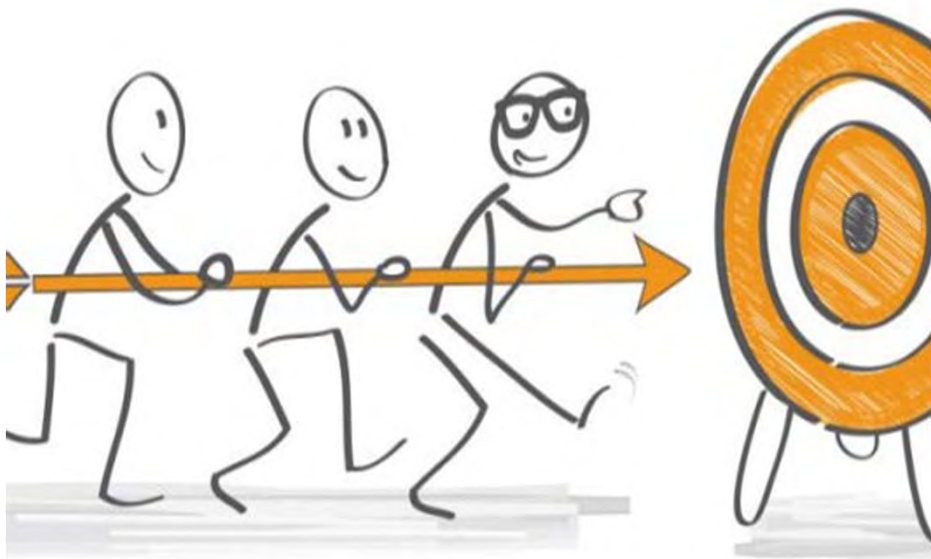
Source: Ecodom

InnoWEEE project – the Cava de' Tirreni pilot for EEE



InnoWEEE project – the expected results

- Public awareness, participation and support
- Local economic and social fabric involvement
- Establishment of easy and feasible waste collection facilities



- Increase of WEEE collection rate towards the EU targets
- Behavioural change

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marco.tammaro@enea.it



INNOVATIVE WEEE TRACEABILITY AND COLLECTION SYSTEM - The Cava de' Tirreni pilot