

PHOTORAMA – A circular model integrated in the PV value chain from concept to field experience

*PHOTORAMA - Photography process from the Lumières brothers -
Panoramic view enabling the full reproduction of the horizon*



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Organization : CEA



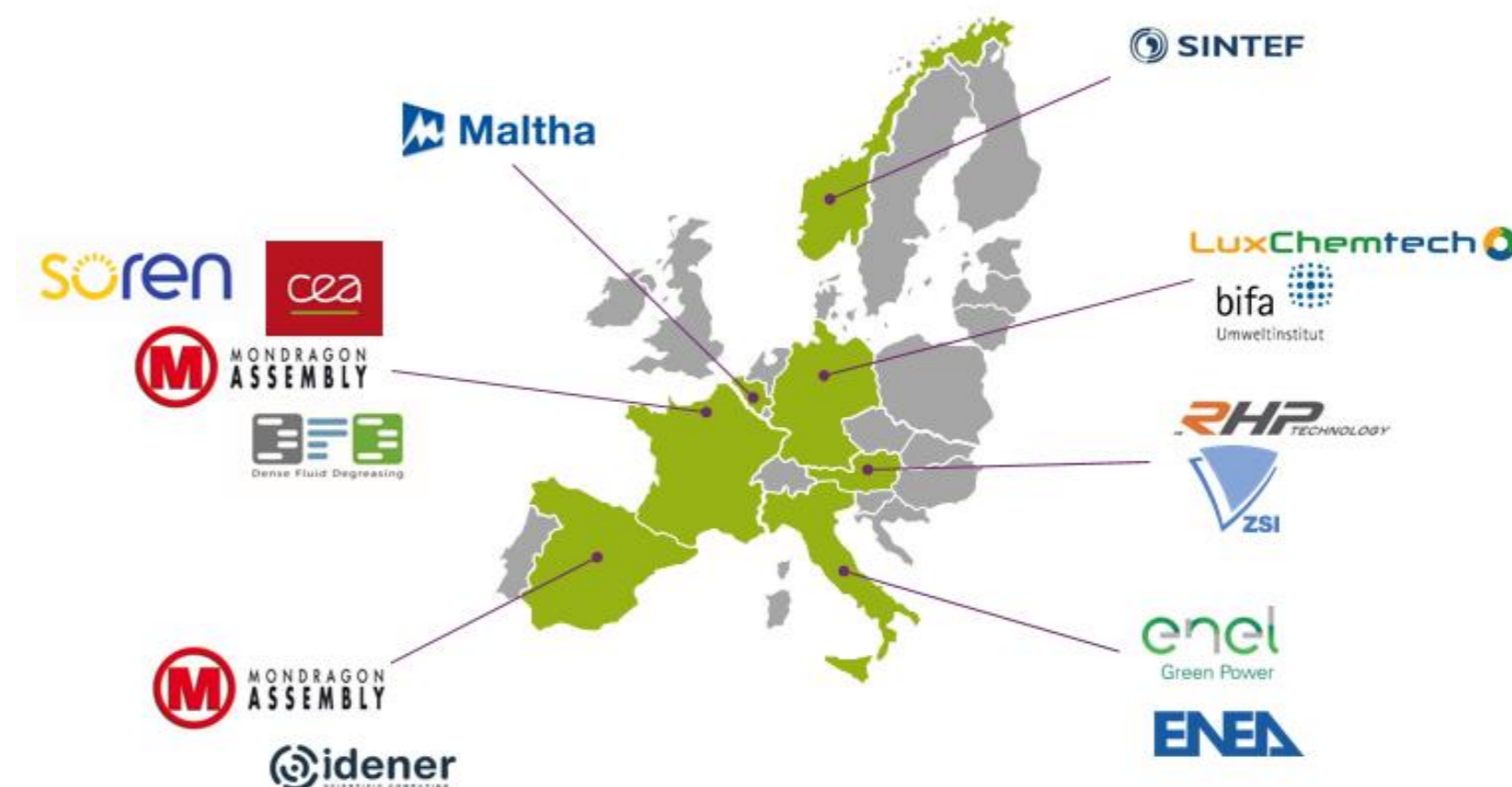
PHOtovoltaic waste management – advanced Technologies for recOvery & recycling of secondary RAw MAterials from end-of-life modules

H2020 project (May 2021 – April 2024)

Budget : 10,365,764.75 €

EC Contribution : 8,381,666.38 €

- 13 partners
- 8 work packages and 5 key objectives
- Set up of a full management Pilot Line



A circular economy across the photovoltaic value chain

“develop innovation leading to successful and competitive solutions to launch sustainable markets for secondary RM in Europe.”





Context

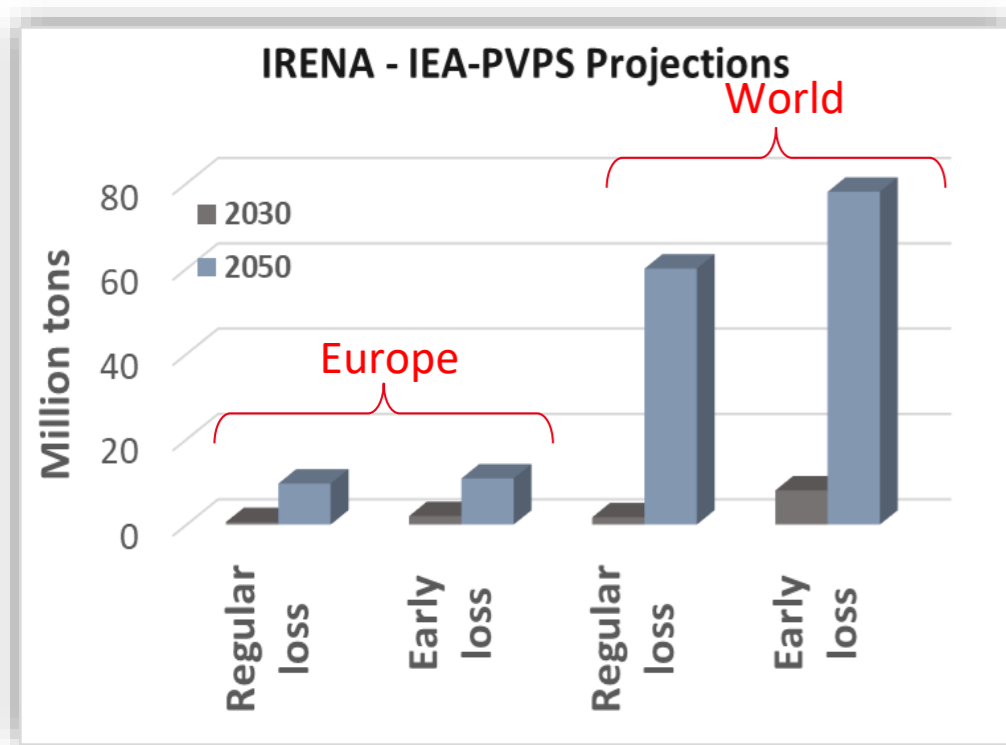
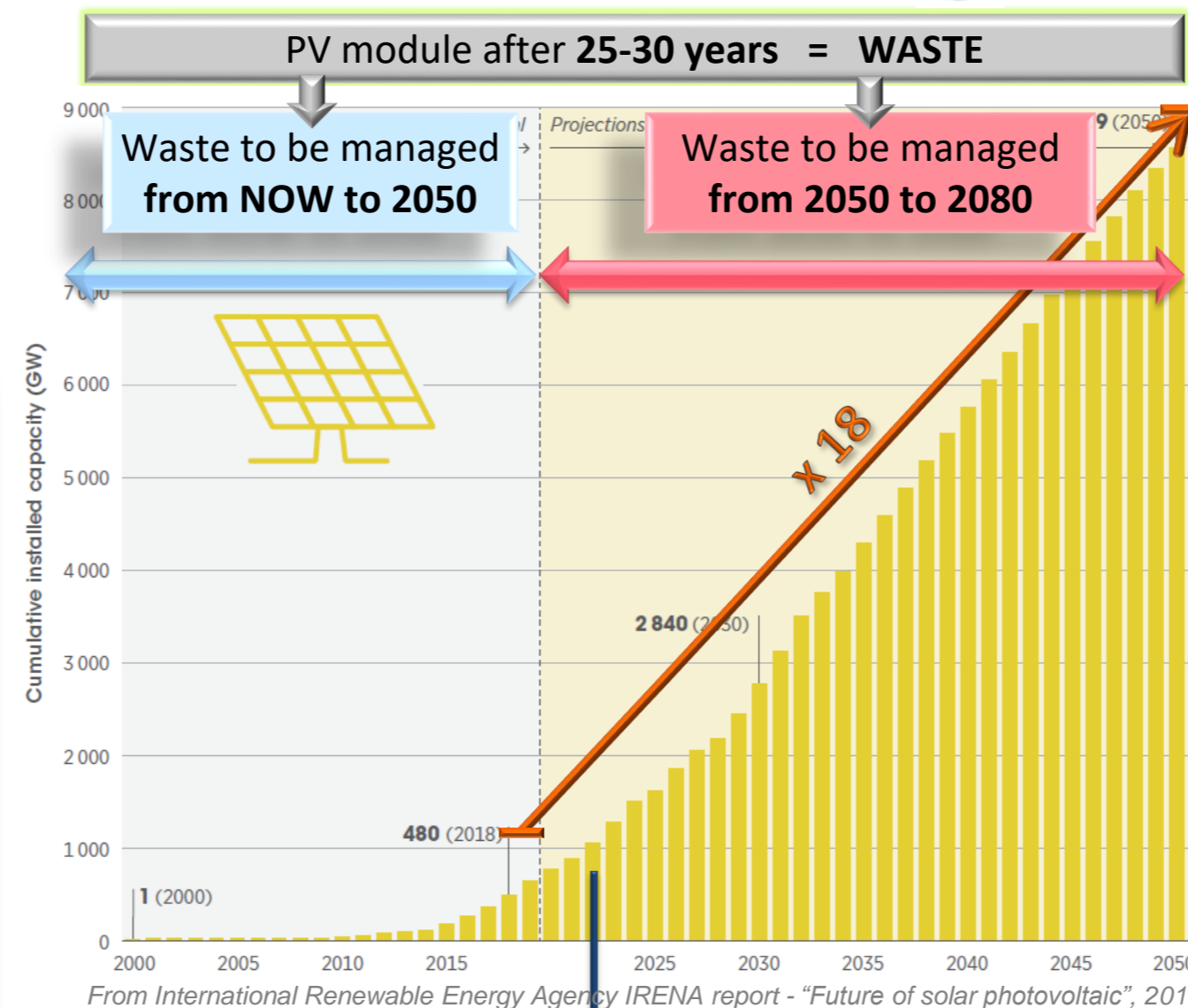


Our project



Perspectives

PV waste ?



* Data extracted from the IRENA & IEA-PVPS, End-of-Life Management: Solar Photovoltaic Panels, 2016

PV waste management



PV waste ?

WEEE 2002/19/E → Category 4 – PV equipment

EN-2-4 - Collection, logistics & treatment for WEEE – Treatment for photovoltaic panels

TS 50625-3-5 - Collection, logistics & treatment for WEEE – Specification for depollution photovoltaic panels



Which kind of WEEE ?

→ Crystalline Silicon- based ~ 95% of the market → 1.6 to 2 m² including 4-5 metals (+traces)

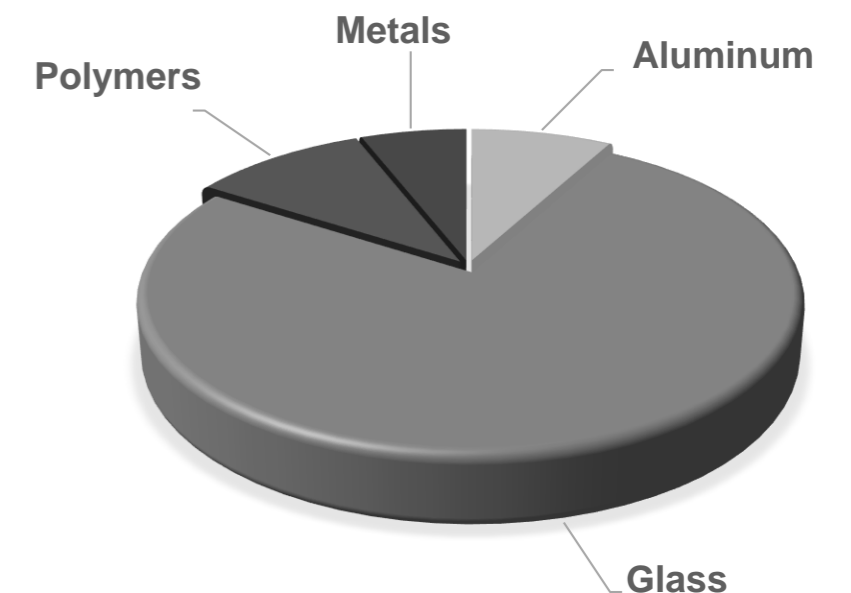
(+ Thin films (CdTe, Cl(G)S) ~ 5 % of the market amongst emerging technologies)

*Compared to a smartphone → ~0.00005 m² including up to 50 metals

How much compared to WEEE stream ?

→ PV waste could exceed 10% of WEEE stream globally by 2050

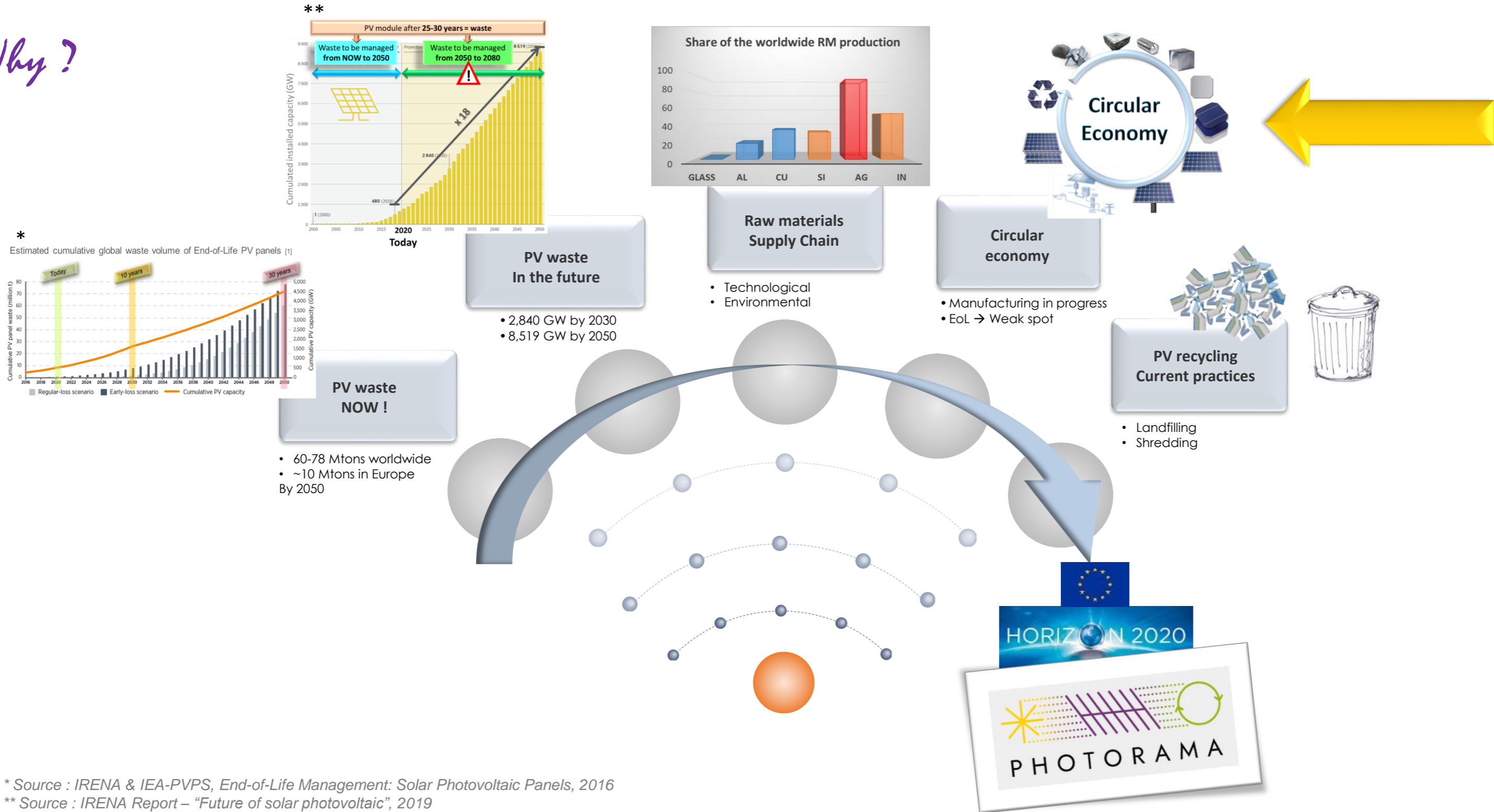
What's to be recovered ??



* Considering the world's population of 2017 assessed by the United Nations and an average power module at 300Wp



Why?



* Source : IRENA & IEA-PVPS, End-of-Life Management: Solar Photovoltaic Panels, 2016

** Source : IRENA Report – “Future of solar photovoltaic”, 2019



This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 958223.

SUSTAINABILITY

What is it?

Sustainability vs “long term” focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs. Sustainability concept made up of three pillars:

- ❖ Economic (profits)
- ❖ Environmental (planet)
- ❖ Social (people)



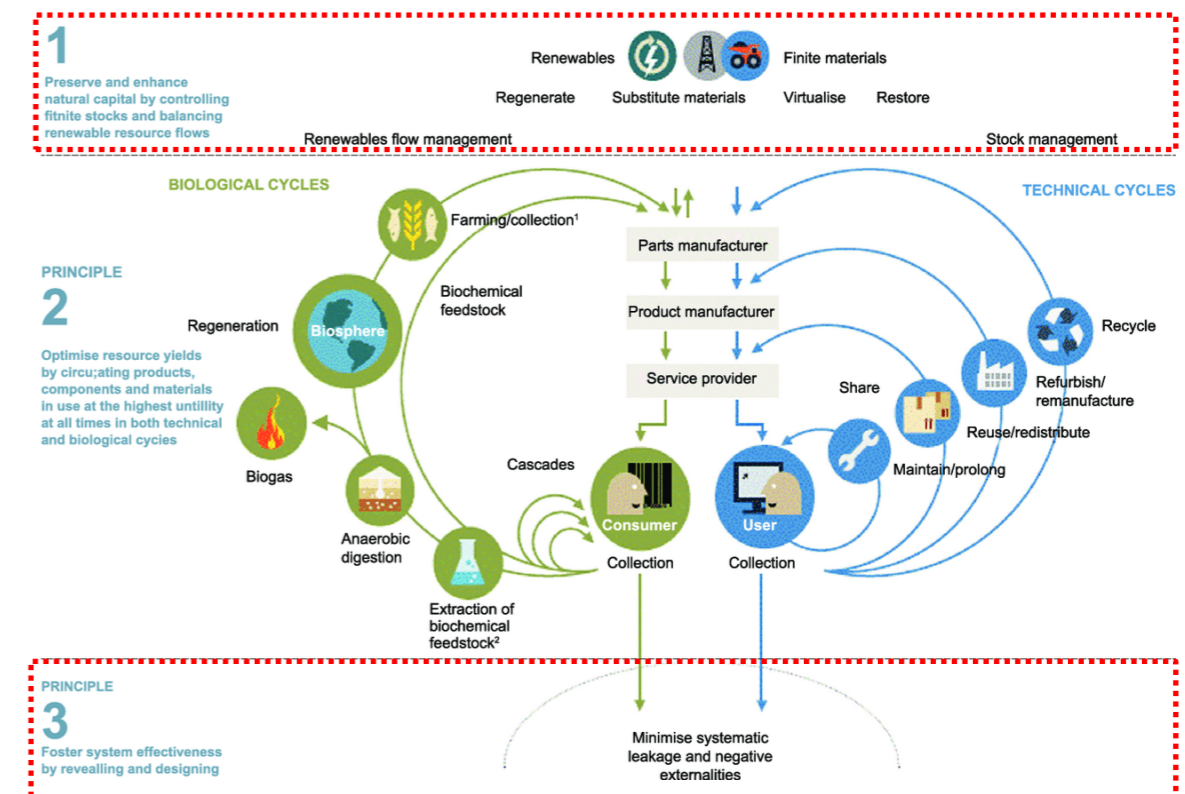
Source United Nations



CIRCULAR ECONOMY

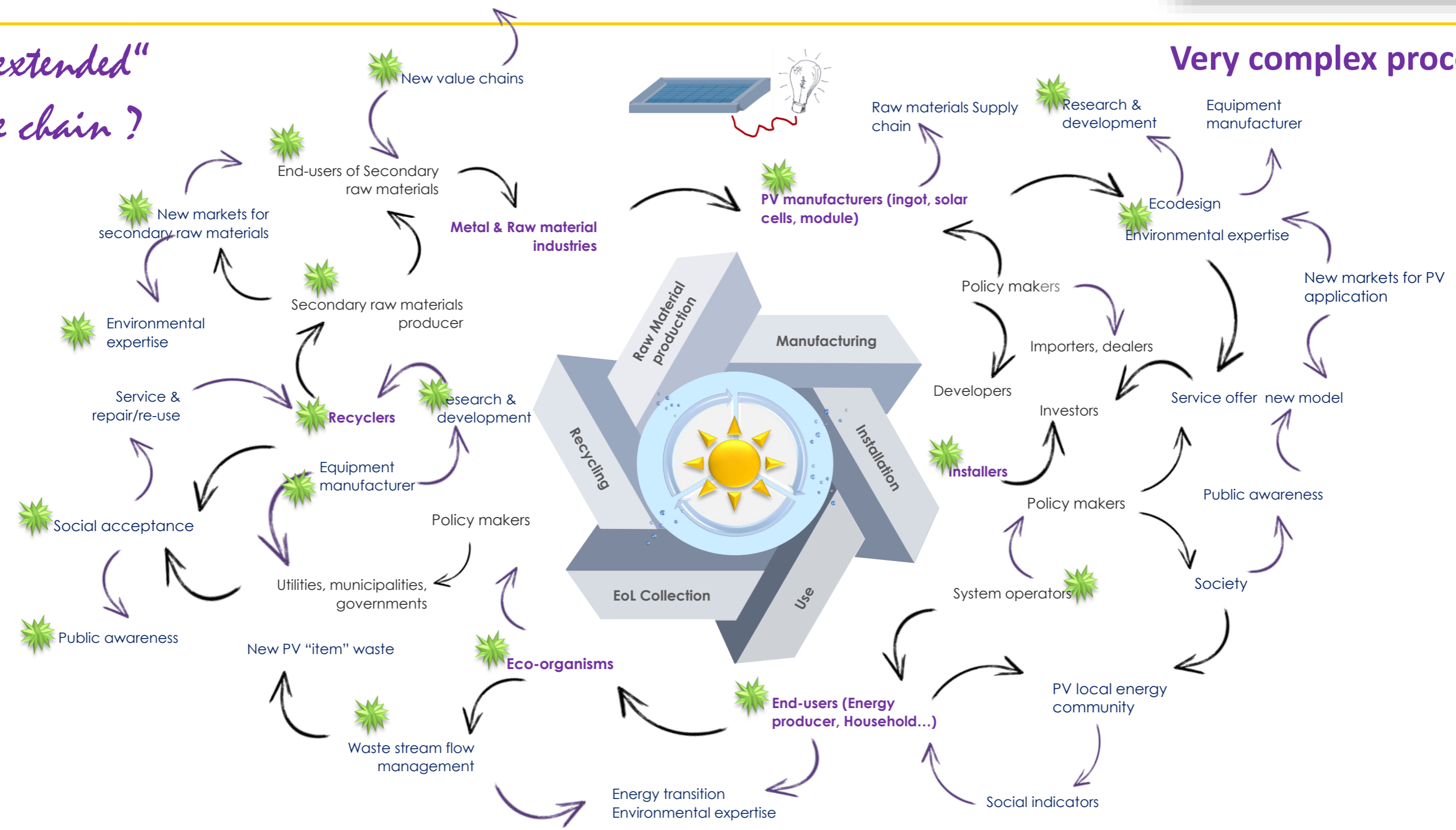
Restorative economy where all the actors in the value chain are dependent on each other to close the loop. Circular Economy concept made up of three pillars:

- ❖ Natural capital – design
- ❖ Resource circularity
- ❖ Systemic efficiency – eliminating externalities



PV "extended" value chain?

Very complex process !





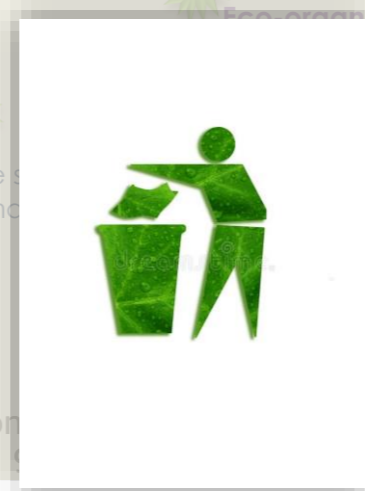
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PV "extended" value chain?

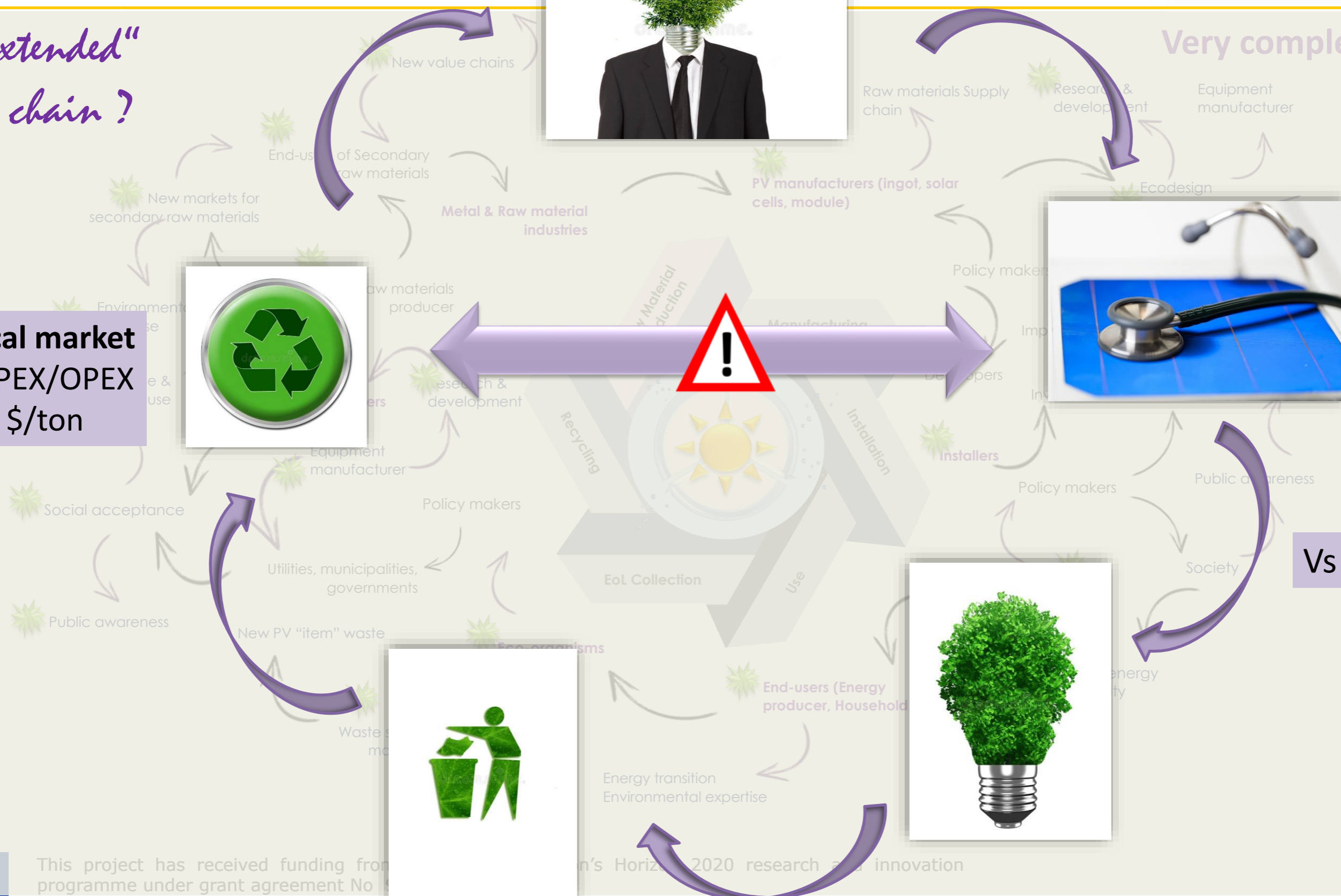
Very complex process !



Local market CAPEX/OPEX \$/ton

Global market CAPEX/OPEX \$/products

Vs ct\$/Wh



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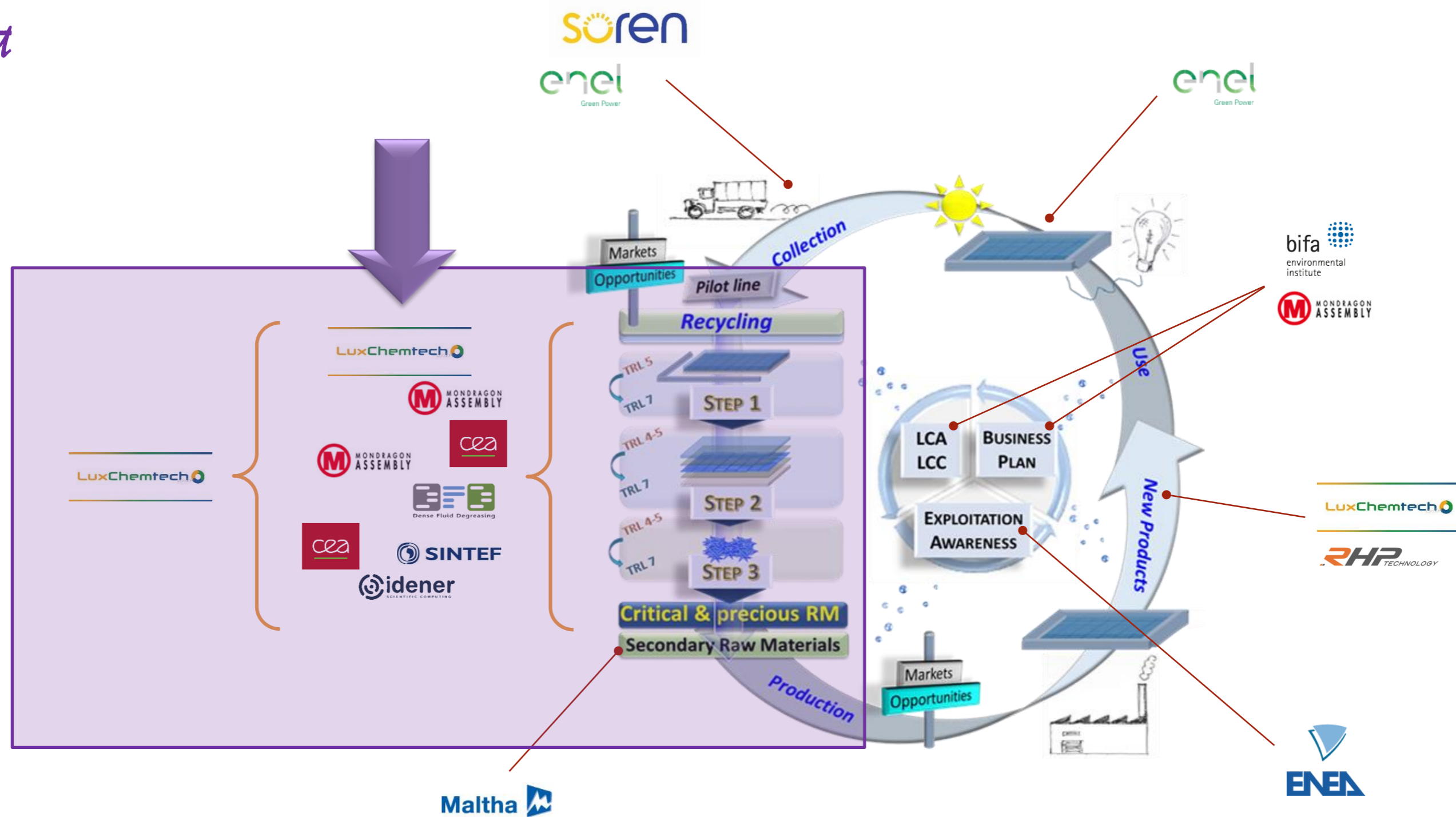


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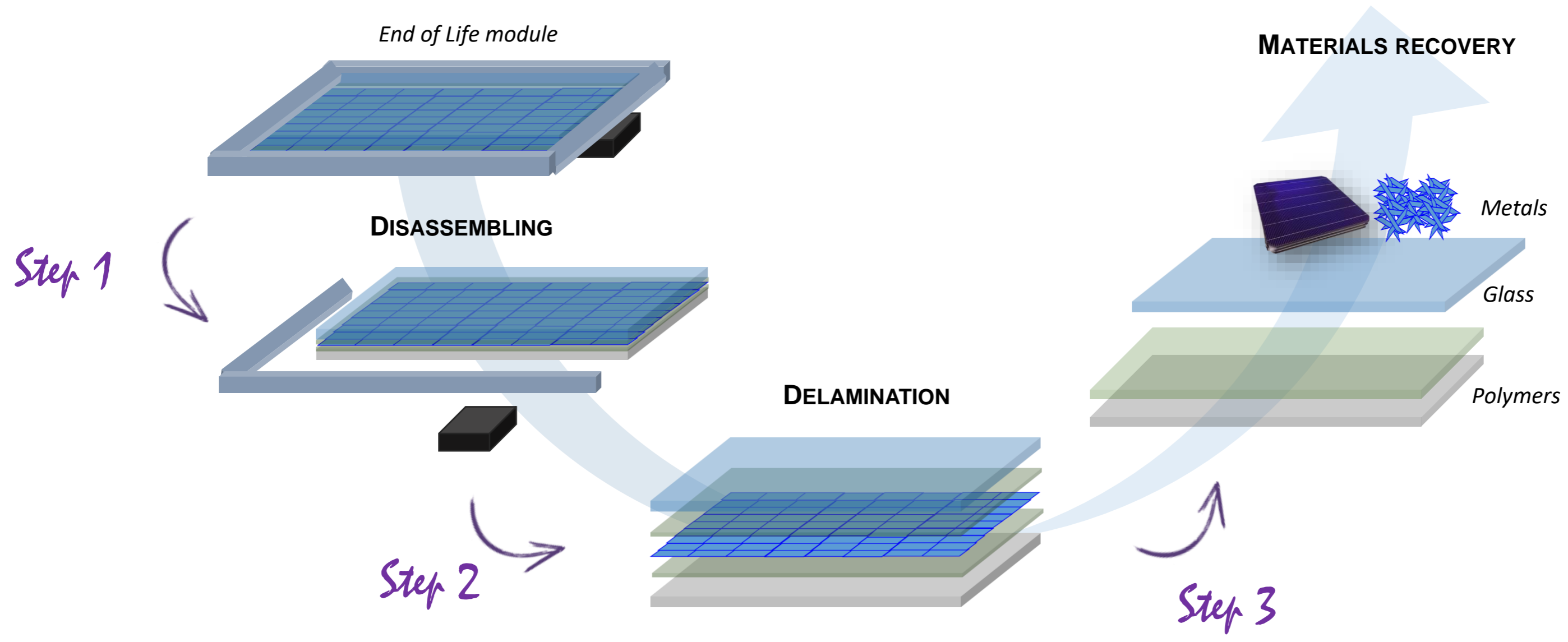
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Our concept



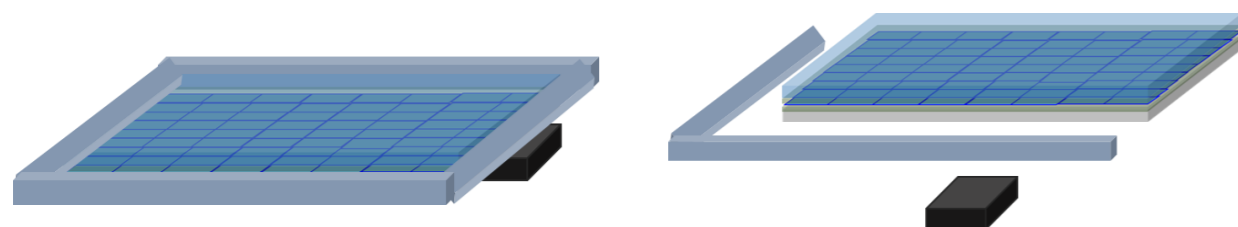
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Our strategy



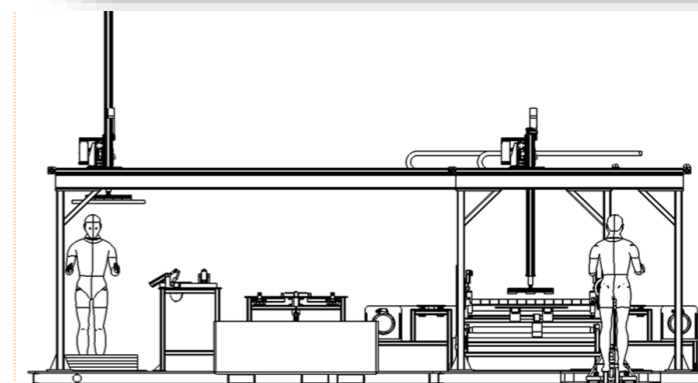
Step 1

DISASSEMBLING



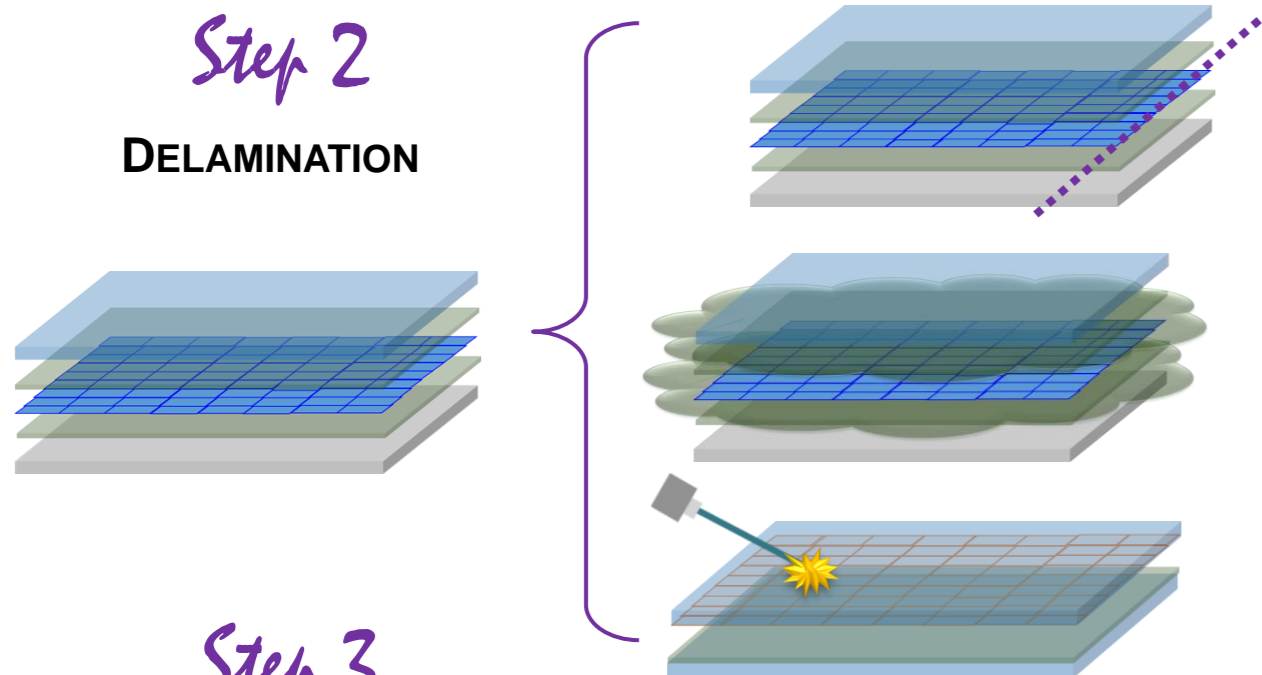
Disassembly of external components

Full-automation panels handling @1200tons/y
 - Removal of junction box (→ recovery others WEEE)
 - Removal of Al frame (→ metal refinery)
 Without breaking the devices



Step 2

DELAMINATION



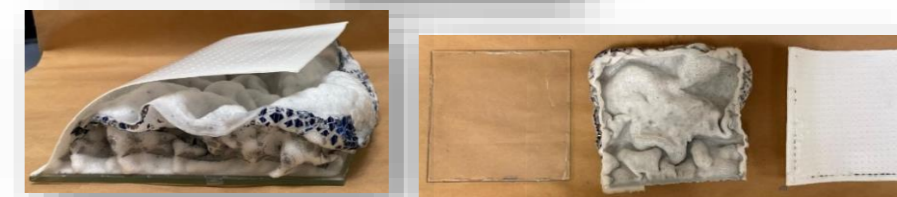
Diamond wire cutting process

Mechanical delamination cutting through
 - Intact glass sheet (recycling or re-use)
 - Cells residues (for step 3)
 - Polymer backsheet (energy fuel)



Super critical fluid process

Mechanical delamination by EVA foaming
 - Intact glass sheet (recycling or re-use)
 - Cells residues (for step 3)
 - Polymer backsheet (energy fuel)

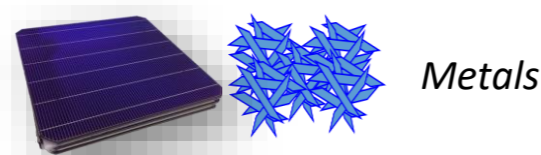
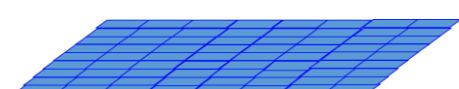


Optical process

Mechanical delamination by EVA foaming
 - Intact glass sheets (recycling or re-use)
 - Cells printed on glass sheet (for step 3)

Step 3

MATERIALS RECOVERY

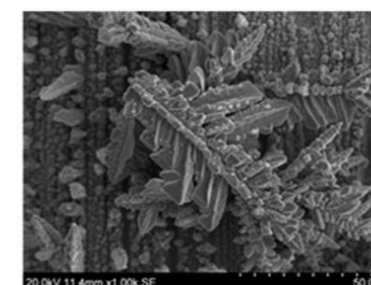


IL leaching & electrolysis

Metals recovery
 - Ag (>99%), Si (MG)

OSA & electrolysis

Metals recovery
 - In (99%), Ga (99%)





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Where we go! Time line

Technology demonstrated in relevant environment – system prototype demonstration in operational environment *

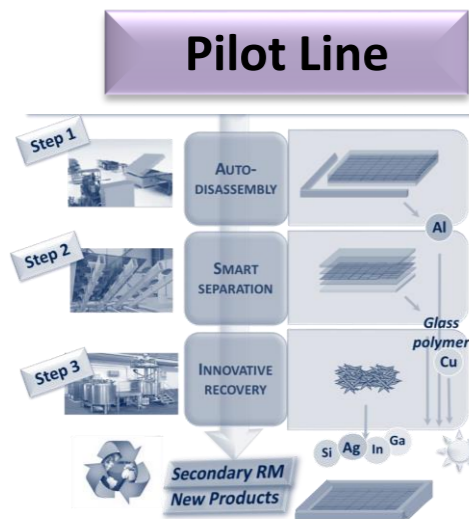
Technology validated either in lab - or in relevant environment*

Operational Pilot prototype M36

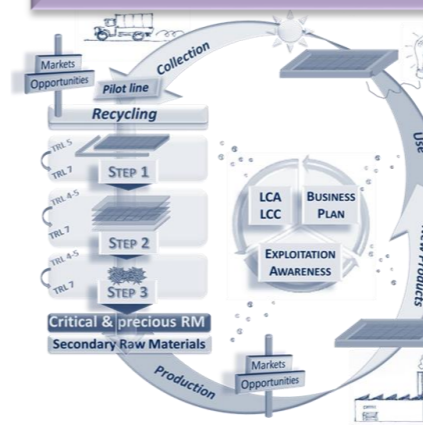
Scale-up TRL6-7 M24

Technological Development M12

Start-up TRL4-5 M1



Circular strategy



*https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf



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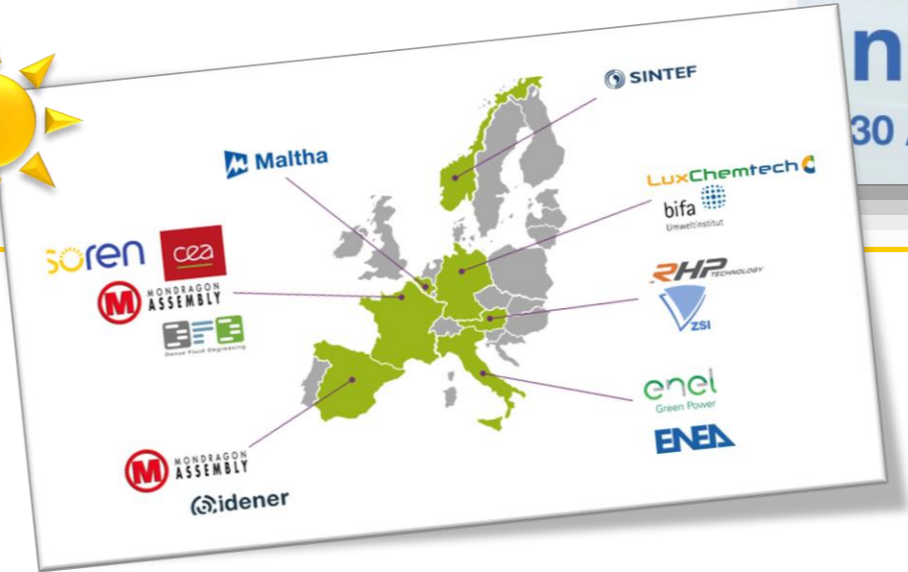
Perspectives

Objectives



Go to Market

- Circular strategy
- New business opportunities



PHOTORAMA team

We've got a story to tell here !



Test in manufacturing

- PV components
- Others value chains

Industrial validation

Technology scale-up

- Disassembly
- Delamination
- Metal recovery

TRL 7 by the end
Pilot line demo
For 1200 tons a year

Secondary Raw materials

- Characterization
- Recovery ratio

New products

- Glass (sheet, cullet)
- Metals (Ag, Si, In, Ga)

High-tech / high-value products

Global recovery ratio > 98 %
Metal purity 98-99.999 %



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Thanks for your attention !



Maltha



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