

Thermal decomposition of the silicon photovoltaic cells covered with EVA and ETFE foil

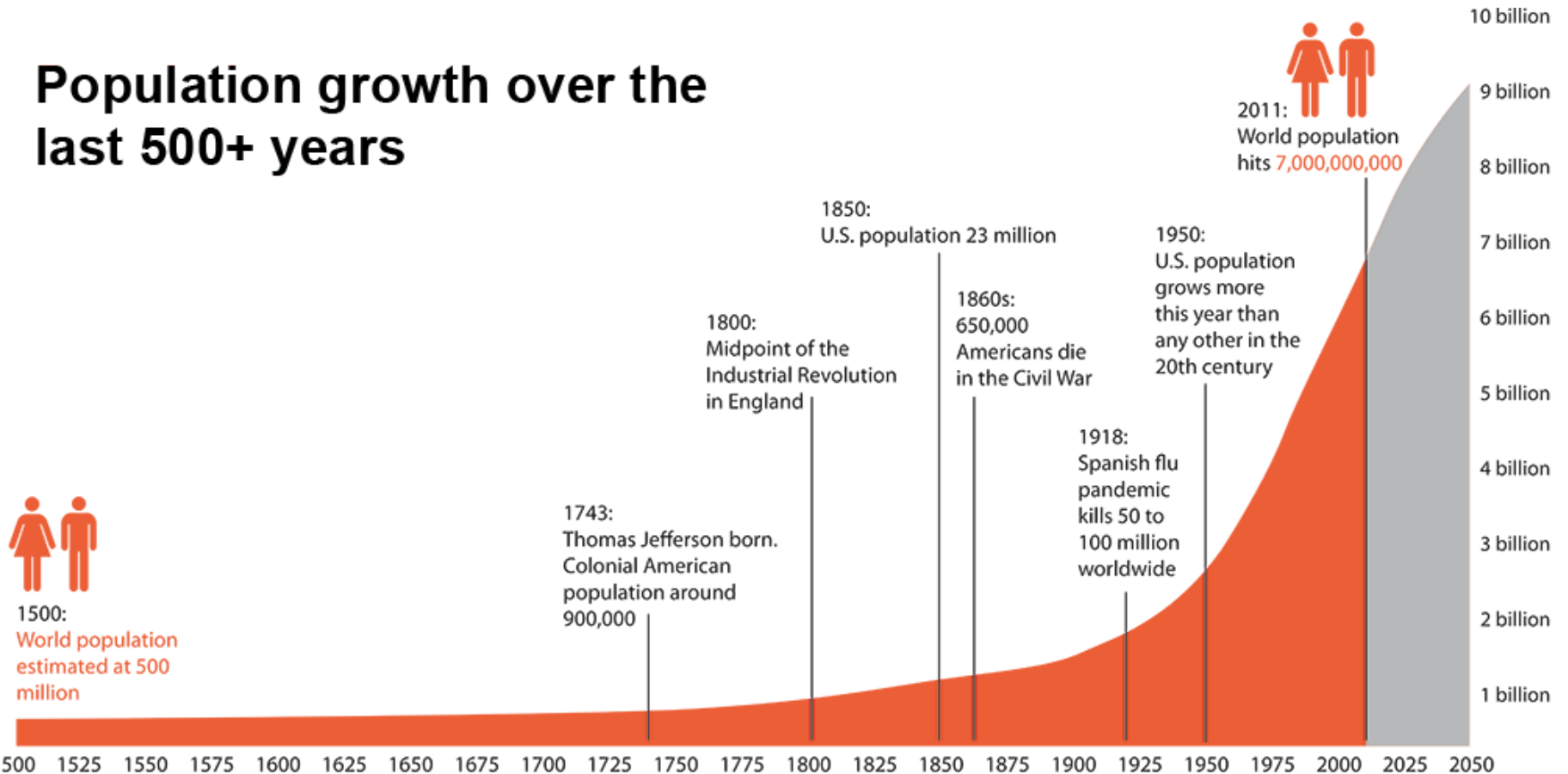
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World development

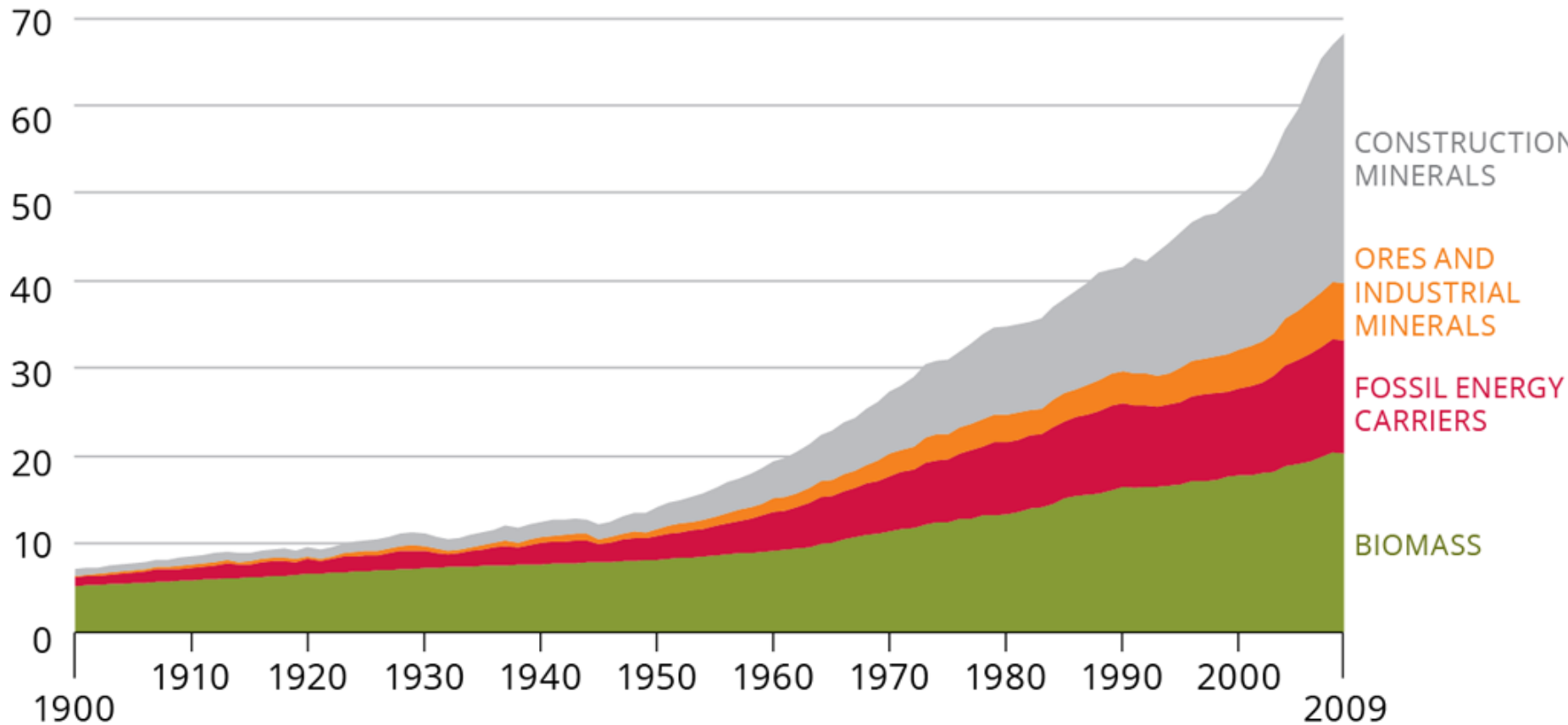


Population growth over the last 500+ years



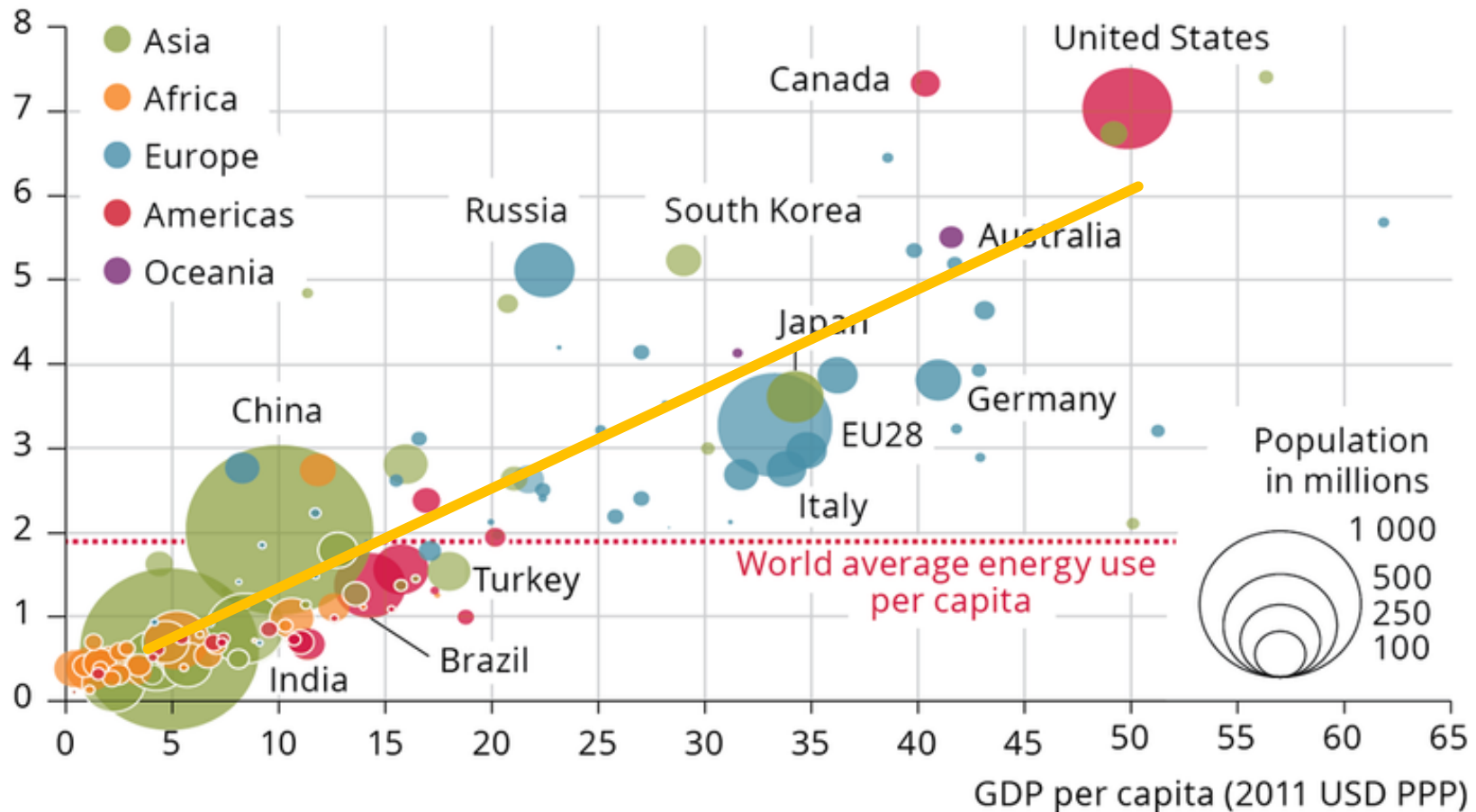
Global total material use by resource type, 1900- 2009

Billion tonnes

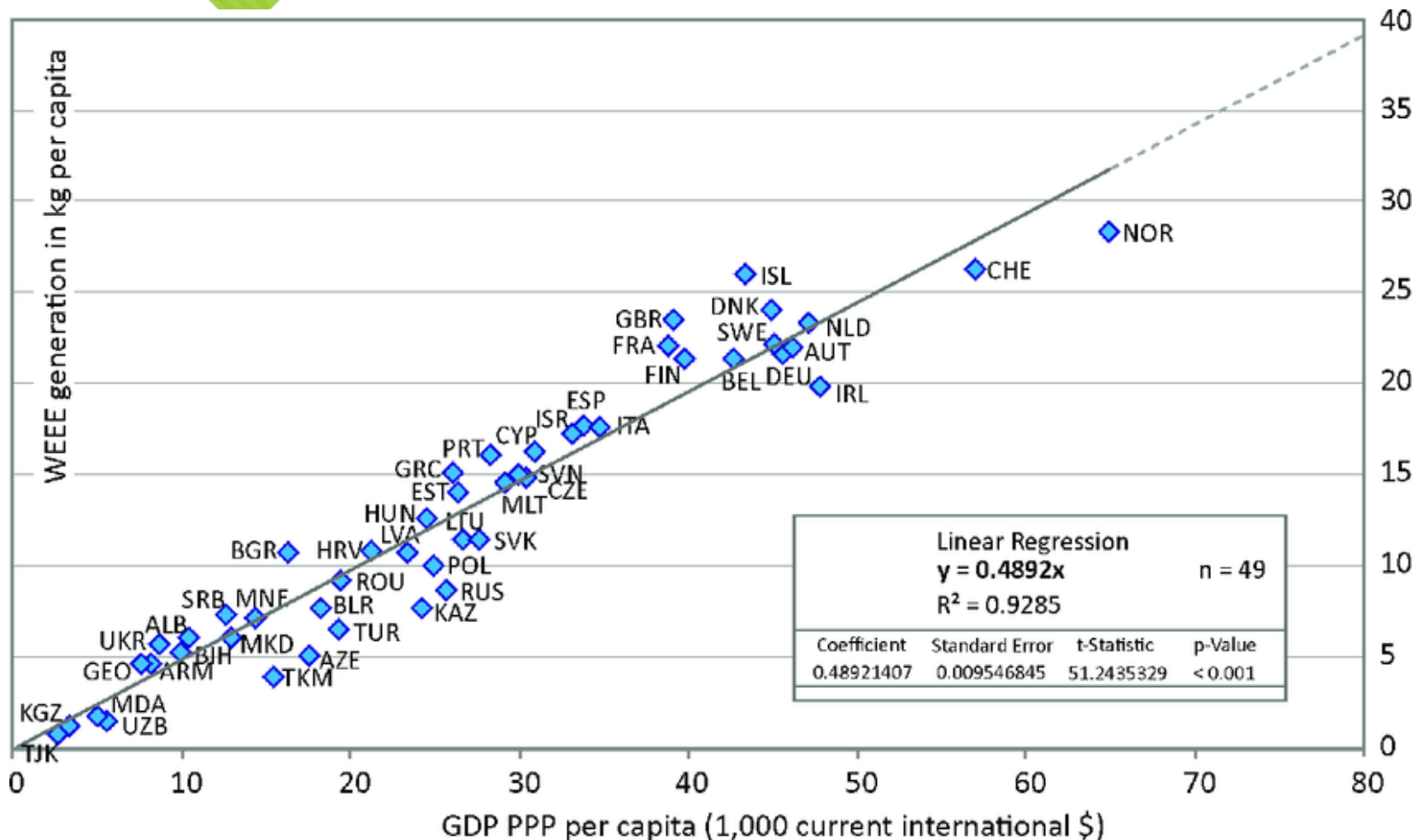


Development means ...

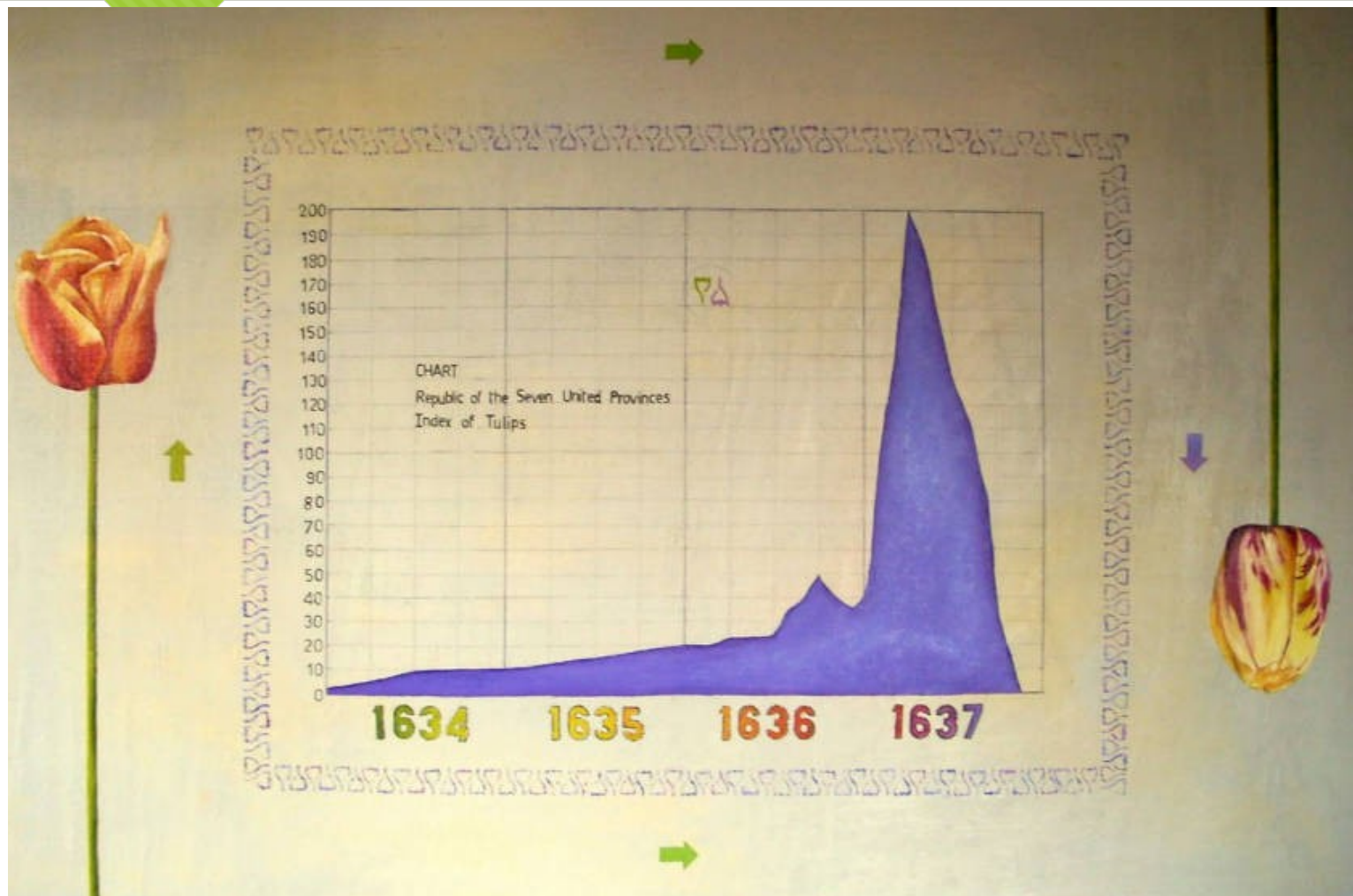
Energy use in tonnes of oil equivalent per capita



Waste Electrical and Electronic Equipment (WEEE)

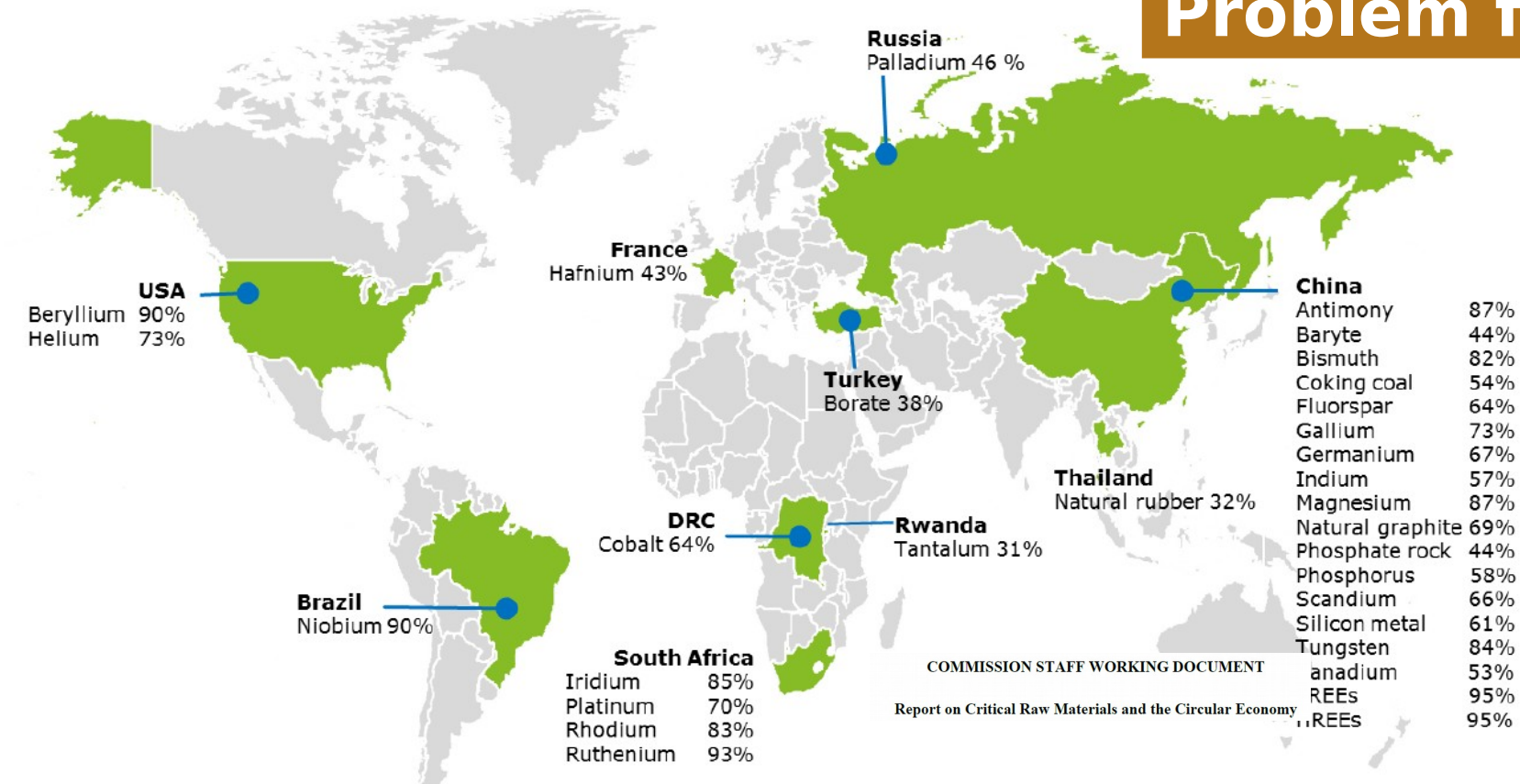


Growth!



The supply ...

Problem for EU

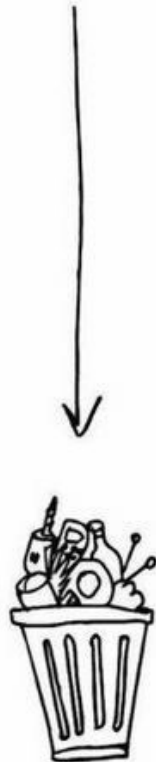


Critical raw materials

Figure 1: Contribution of primary global suppliers of critical raw materials, average from 2010-2014

ONGOING EVOLUTION

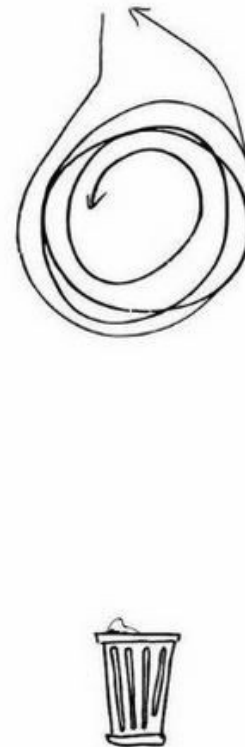
LINEAR ECONOMY



RECYCLING ECONOMY



CIRCULAR ECONOMY

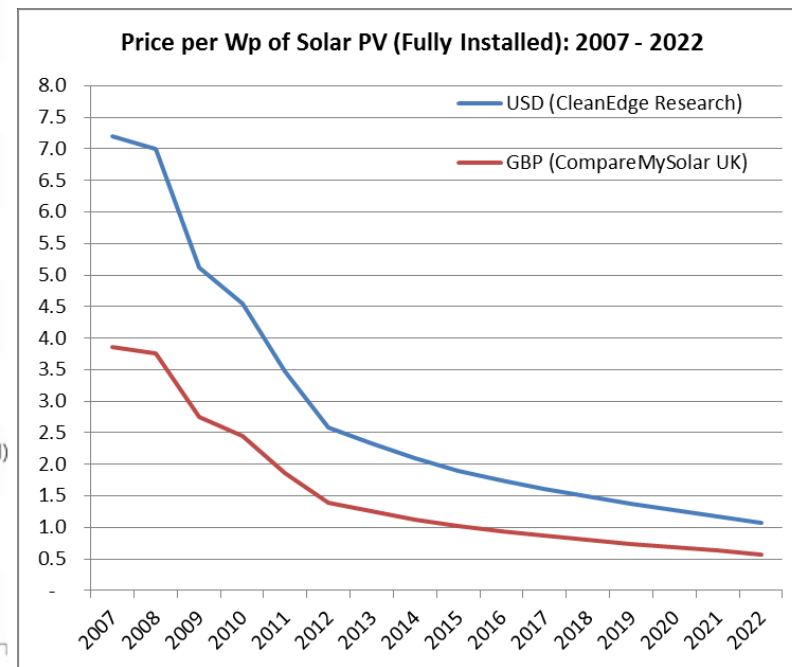
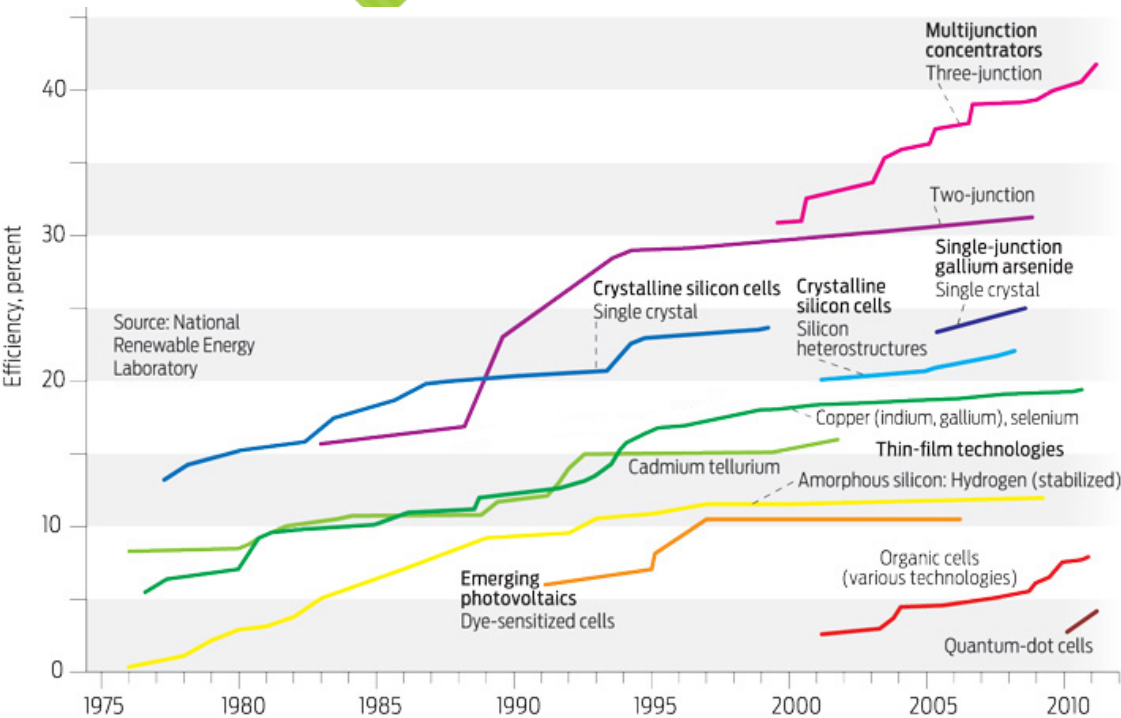


The future ...



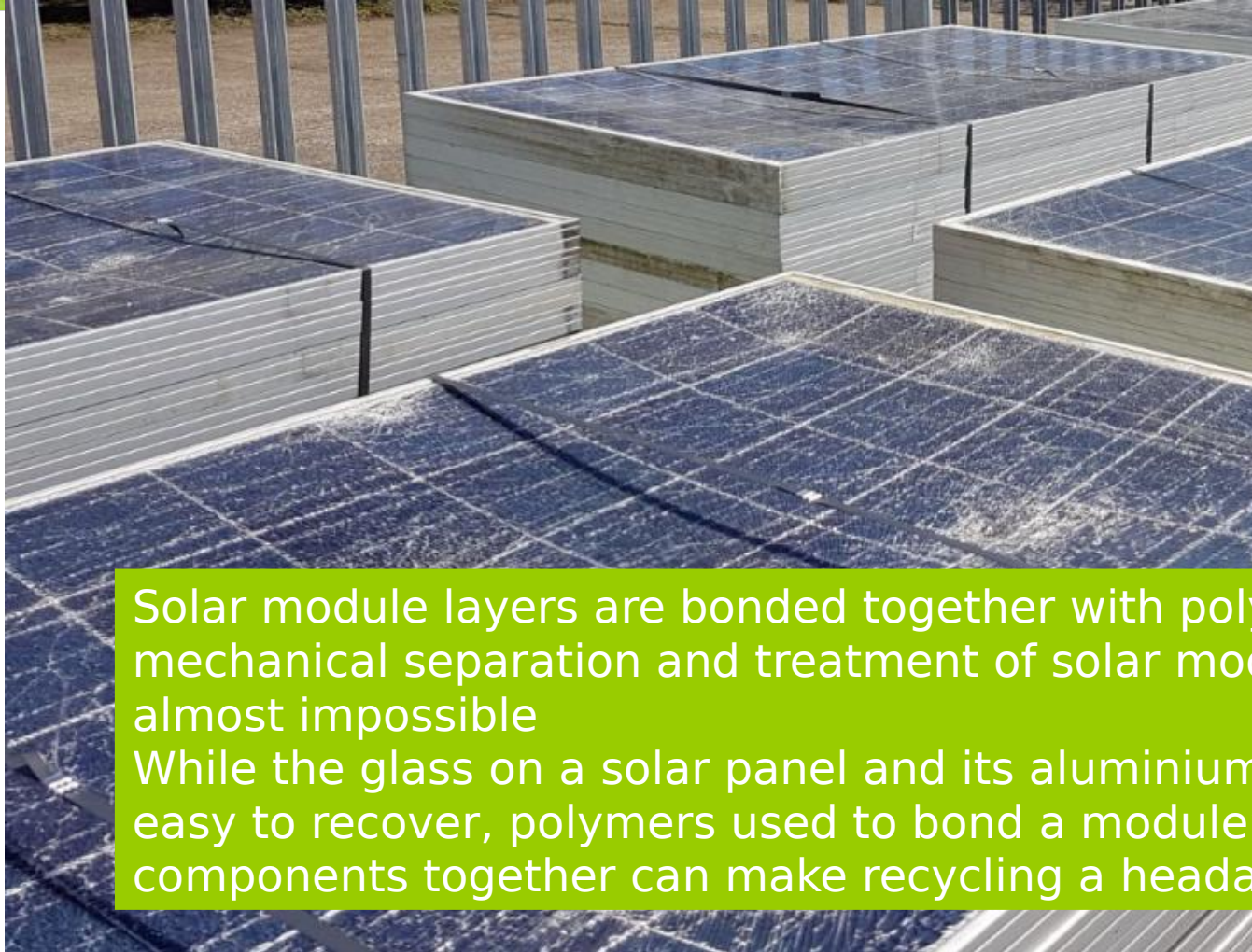
**Zero
emission**

The Challenge ...



Solar panels that were installed in around the millennium are expected to be ready for disposal by the early 2030's
it's estimated there will be between 60-78 million tonnes of PV panel waste globally by 2050 (cumulative)

The Challenge ...

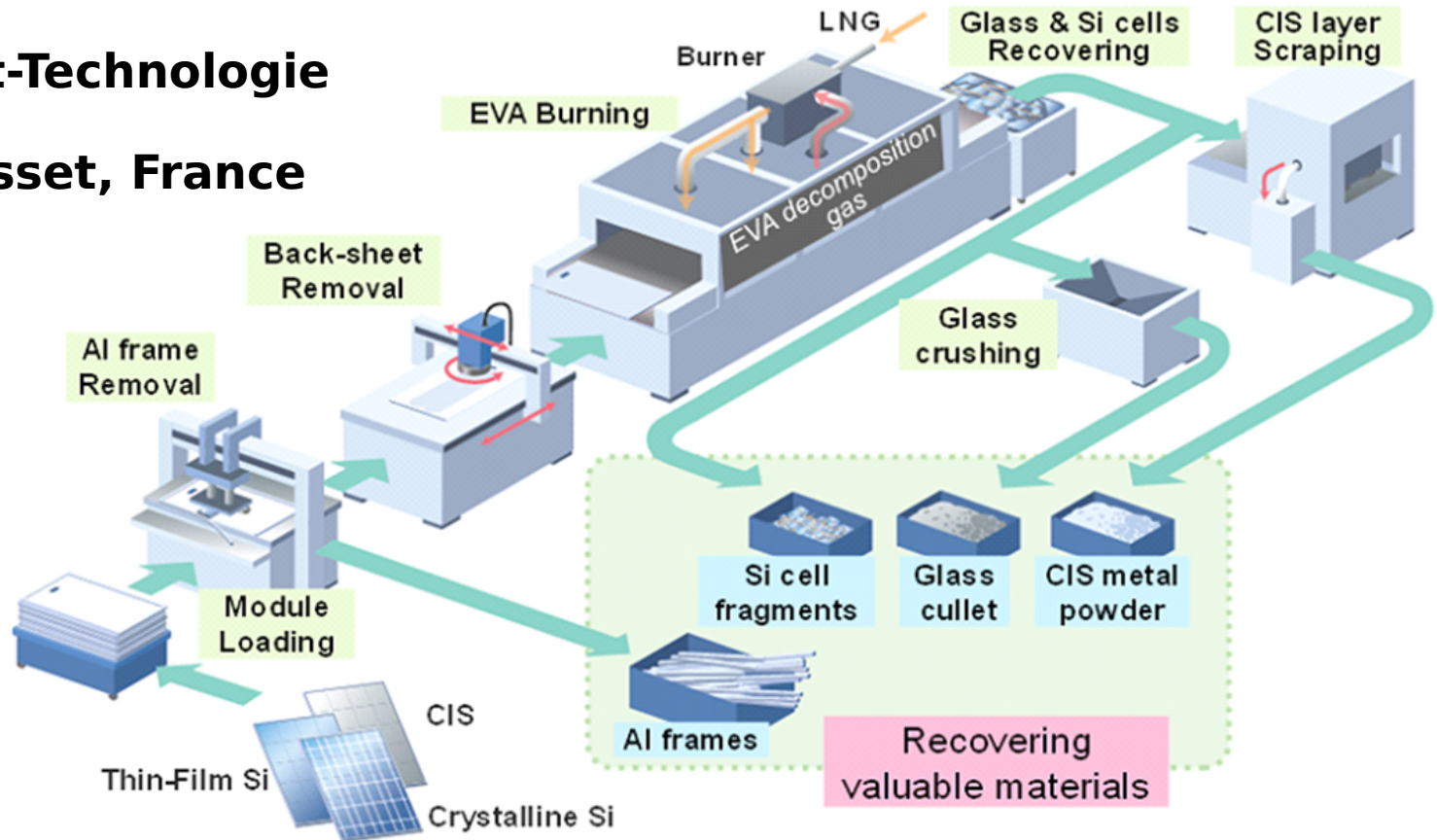


Solar module layers are bonded together with polymers that make mechanical separation and treatment of solar module components almost impossible

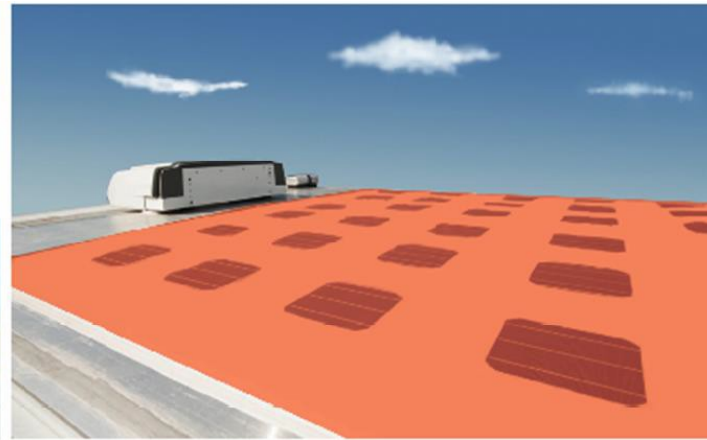
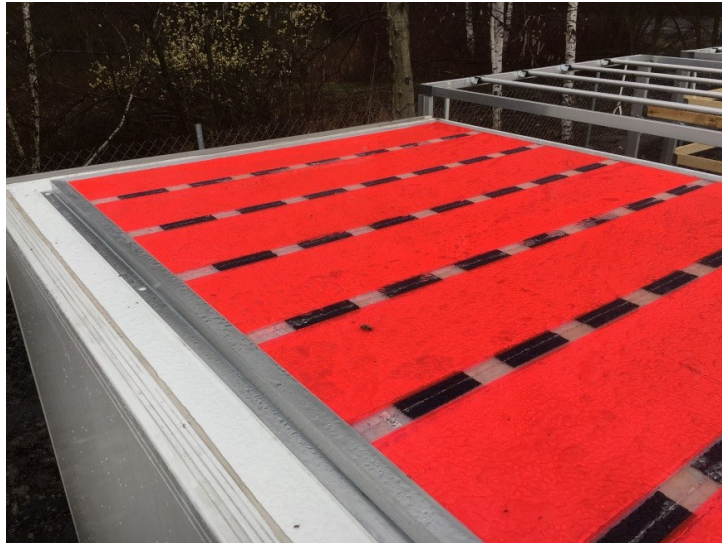
While the glass on a solar panel and its aluminium frame are relatively easy to recover, polymers used to bond a module's various other components together can make recycling a headache

The solution ...

Geltz Umwelt-Technologie
Veolia in Rousset, France



PV panels with dye concentrator ...

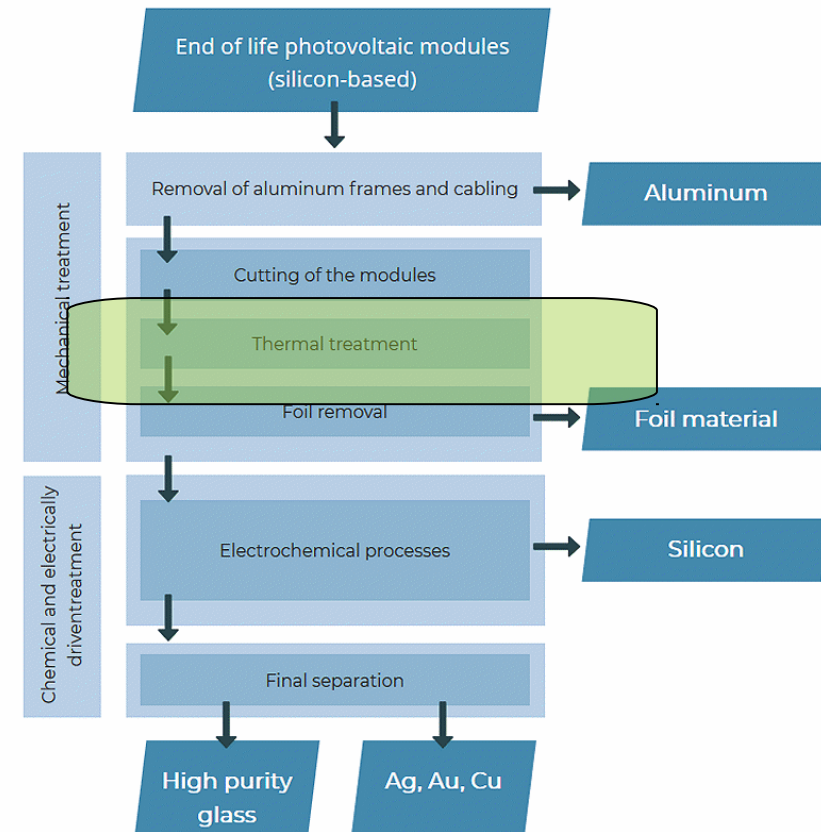


What are options?

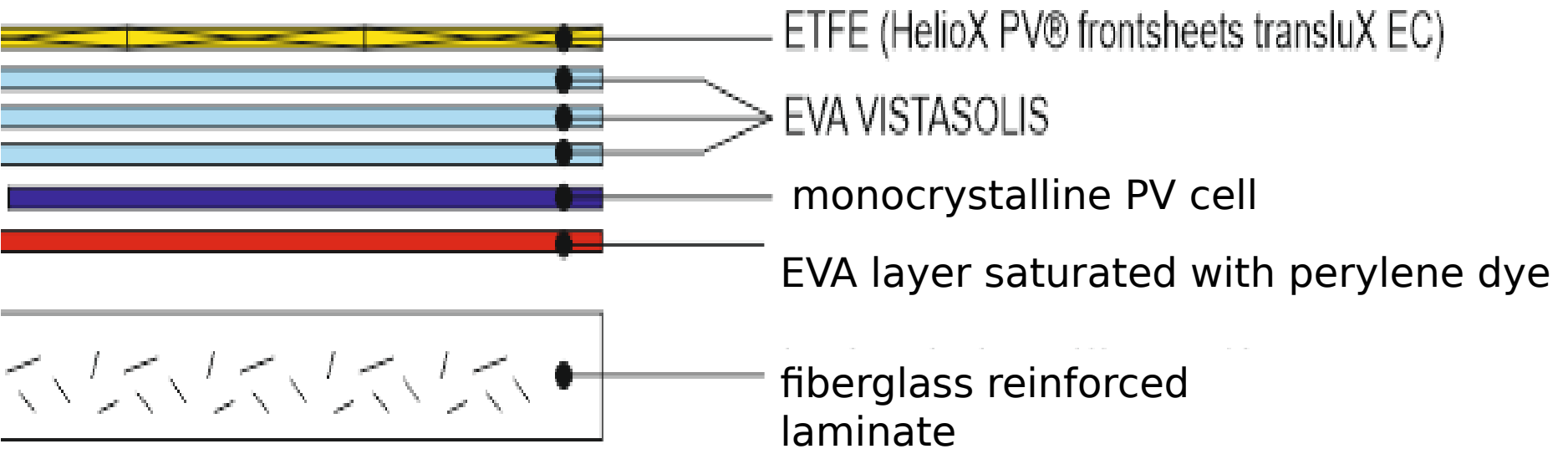


Up until now, there has not been any technical solution to recycle and separate the valuable materials from the mixed scrap. The critical step in the recycling process is therefore the destruction of the polymer layers,

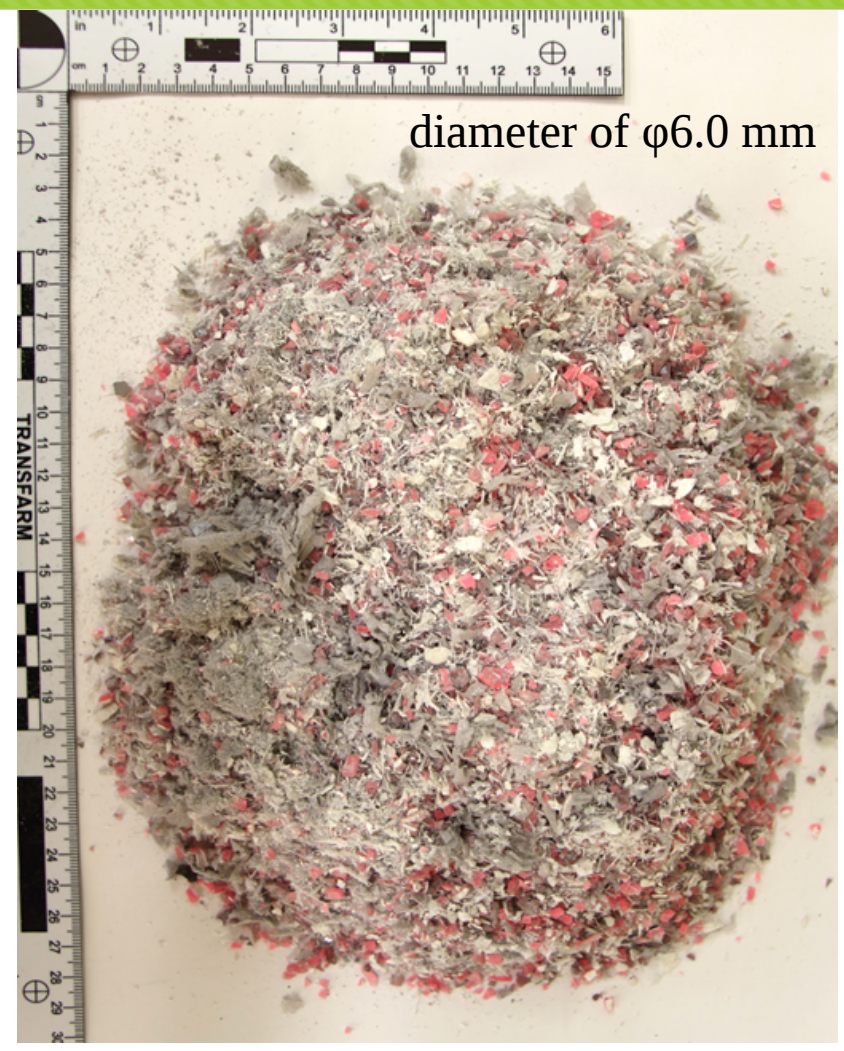
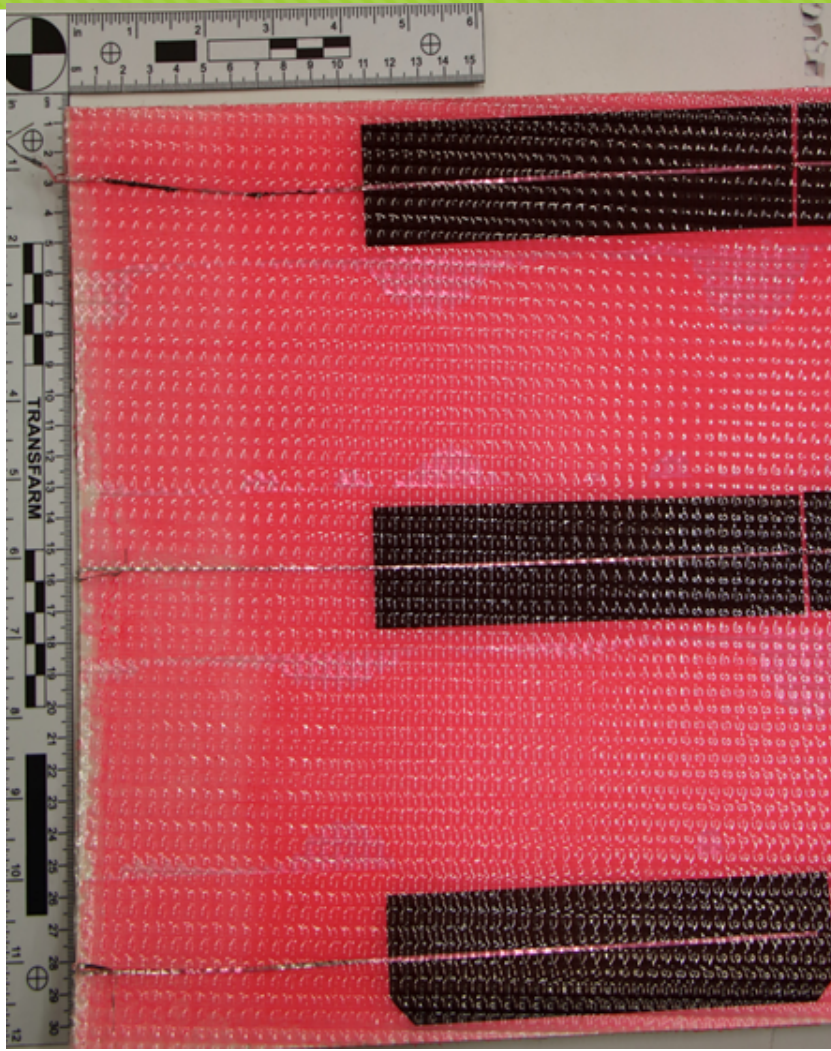
Thermal treatment?



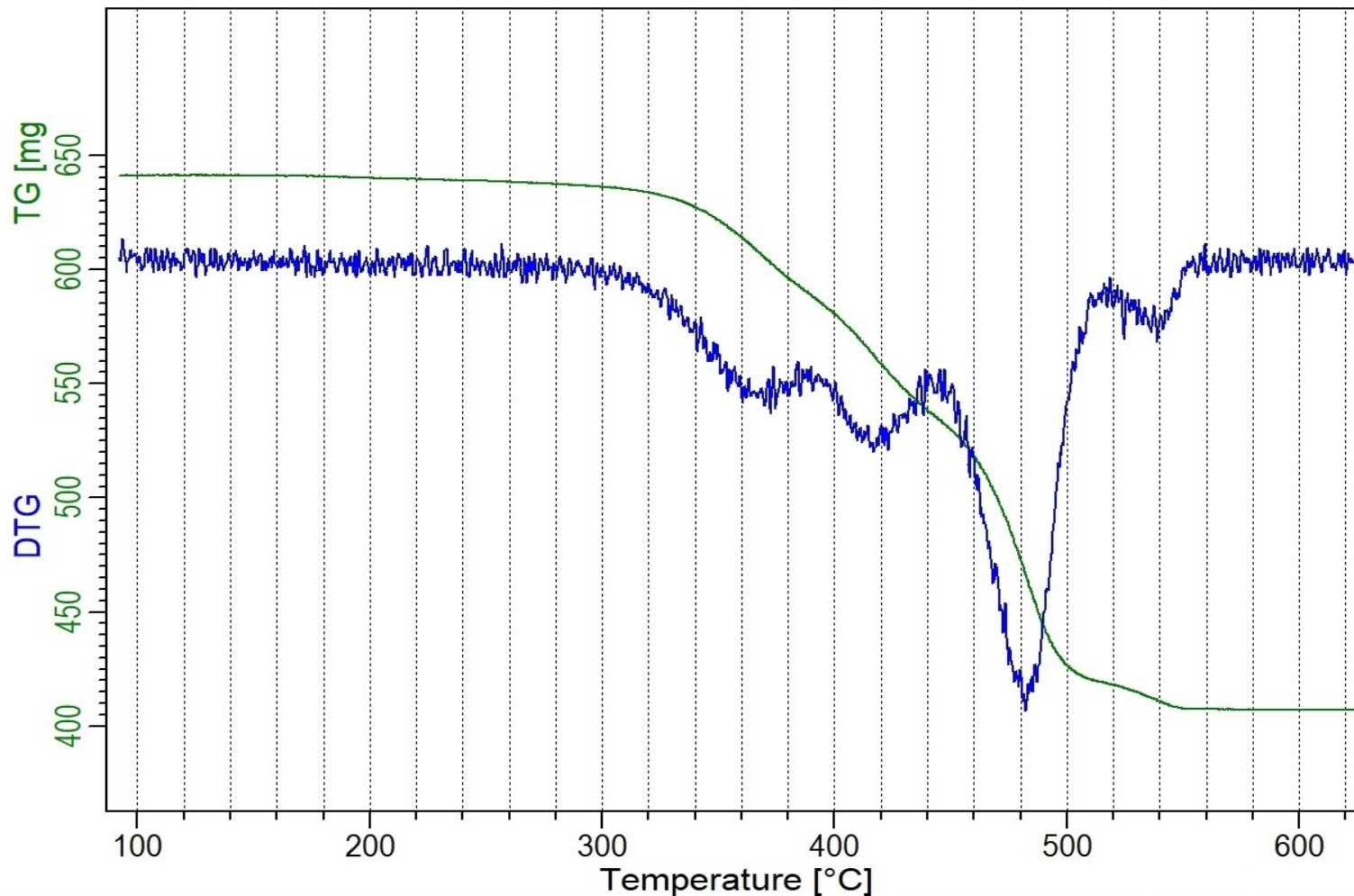
Materials



Materials



TGA - Thermogravimetric



The pyrolysis



The products...



As a result of pyrolysis, 46.86% weight loss was observed

The material balance from the pyrolysis process of 3 fractions is respectively 53.14% solid phase, 24.28% liquid phase, 22.58% gas phase.

The concentrations: Br, Cl and F in the gas (above oil)

- Chromatographic analysis showed the presence of acetaldehyde, propionaldehyde and traces of acrolein.
- In addition, GC/FPD analysis was carried out, which showed that the tested sample does not contain sulphur compounds.

Sample number	Element	Concentration [mg/l]
P1/4	Cl	<0.40
	Br	2.00
	F	33.50

analysis of the content of polycyclic aromatic PAHs in the oil

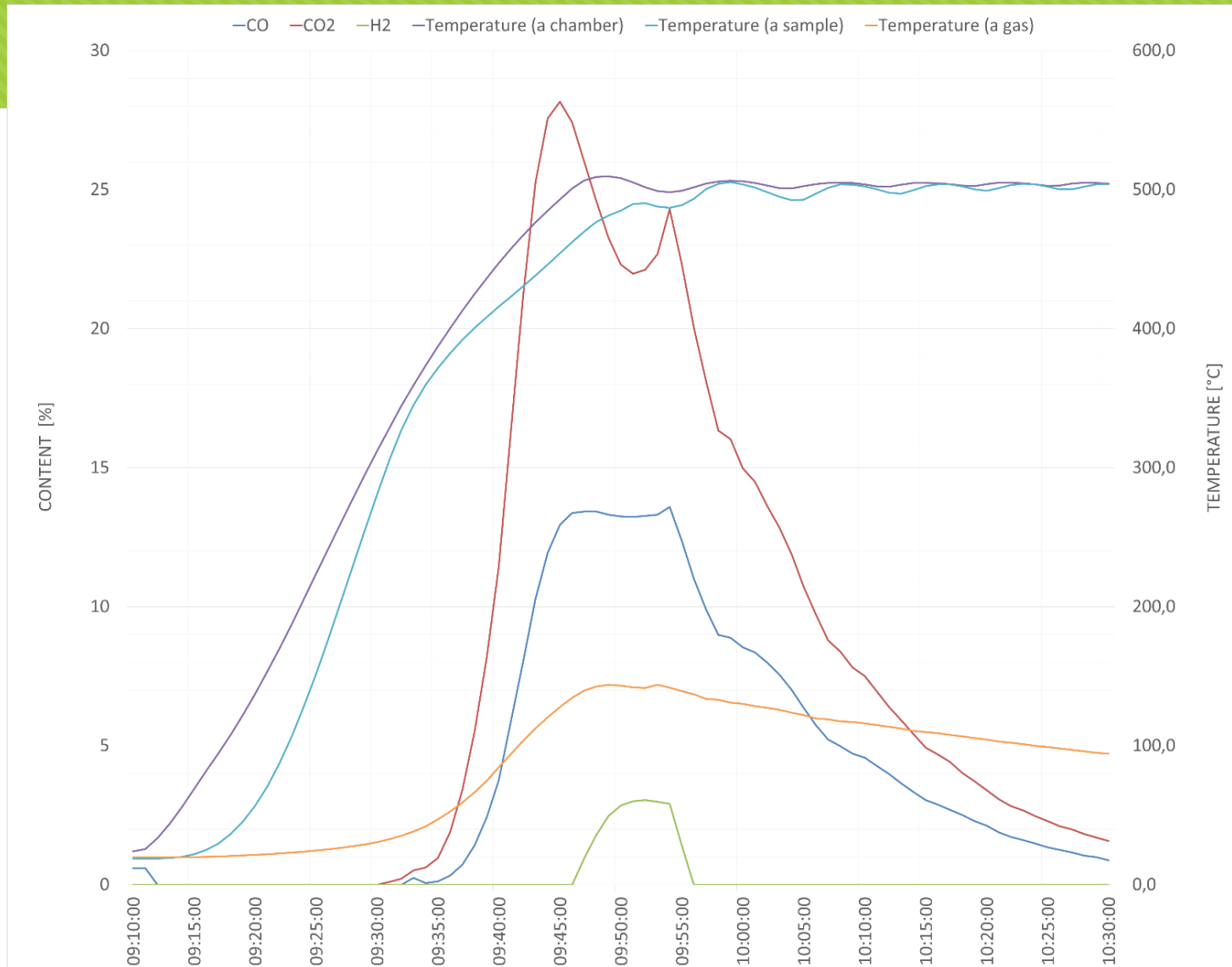


Sample number	Substance determined in the sample	Content in the sample [mg/0,045 m ³]	Markability [mg]	Analytical extended uncertainty [±mg]	Content of substance [mg/m ³]
P1/1	Total hydrocarbon content calculated as toluene	136.76	0.02	n.d.	3039.11
P1/2	Acenaftylen	18.96	0.02	2.838	3039.11
	Naftalen	1.77	0.03	0.269	421.33
	Acenaften	79.42	0.03	15.79	39.33
	Fluoren	0.010	0.01	0.001	1764.89

LHV and moisture content of the carbonize

	Min.	Max.
LHV [MJ/kg]	10,69	11,023
Moisture content [%]	0,75	0,75

Carbonization process



Summary

- The need for PV panels waste recycling is increasing
- The problem of recycling of PV cells is a very complex, especially due to the diversity of PV cells.
- In the case of cells with a concentrator, the processing can be even more complicated due to the content of harmful substances.
- The high-temperature processes like pyrolysis, can help to solve this problem and demonstrate the high quality of end products.
- The analyse carried could be used in order to determine possibilities of thermal treatment of PV panels as a form of its utilization.
- It showed that pyrolysis process and the resulting products require further chemical analysis to optimize the process and places and forms of use of pyrolysis products.

More details information in the article.

Thank you for your attention...



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