Solar module Recycling

Geltz Umwelttechnologie

- Special plant engineering & waste management

Horizon 2020 Project ELSi: Partners

Geltz Umwelt-Technologie

SUEZ

REVATECH

variata
Metall – wir leben es

Fraunhofer IGB

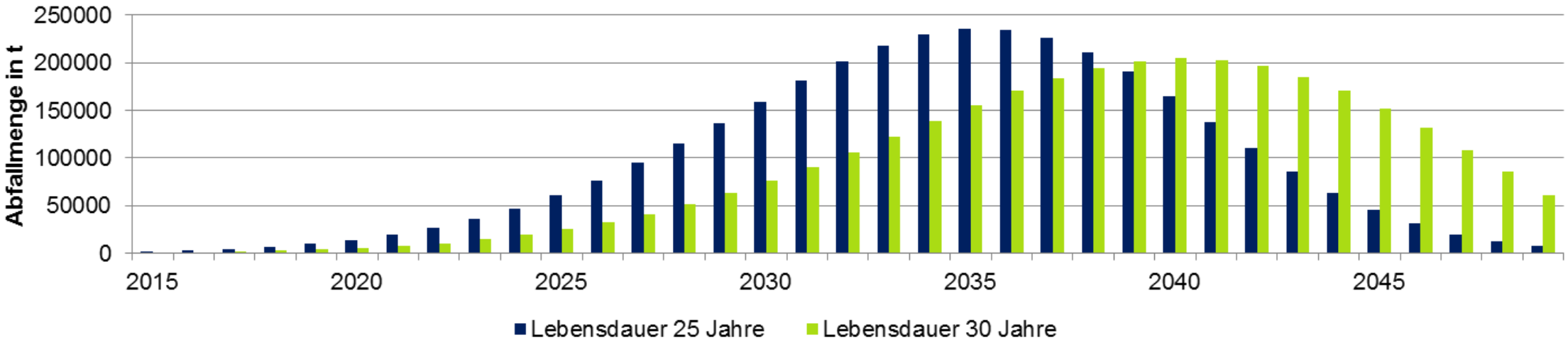
solartys

This project has received funding from the European Union's Horizon 2020 research and innovation pro-gramme under grant agreement No 701104.

Goals of ELSi

- Recycling of solar modules
- Recovery of
  - Silver
  - Silicon
  - Glas
  - Aluminium
  - Copper

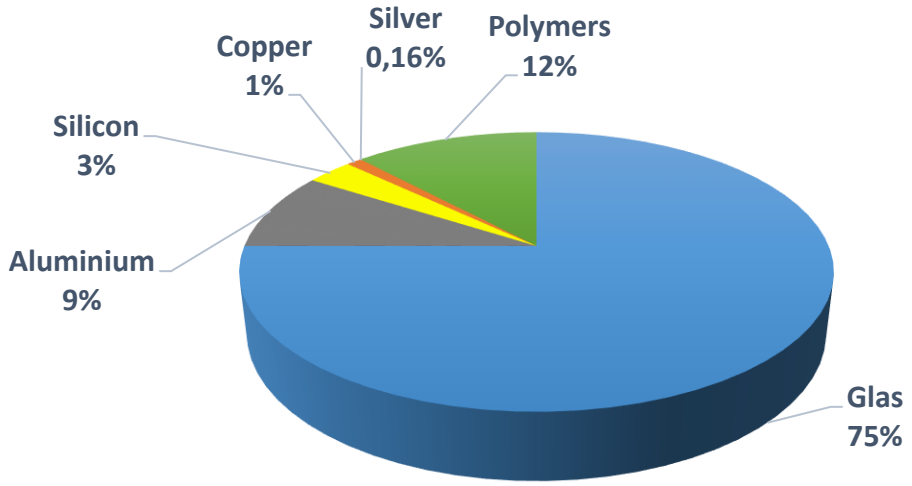
Market development in Germany



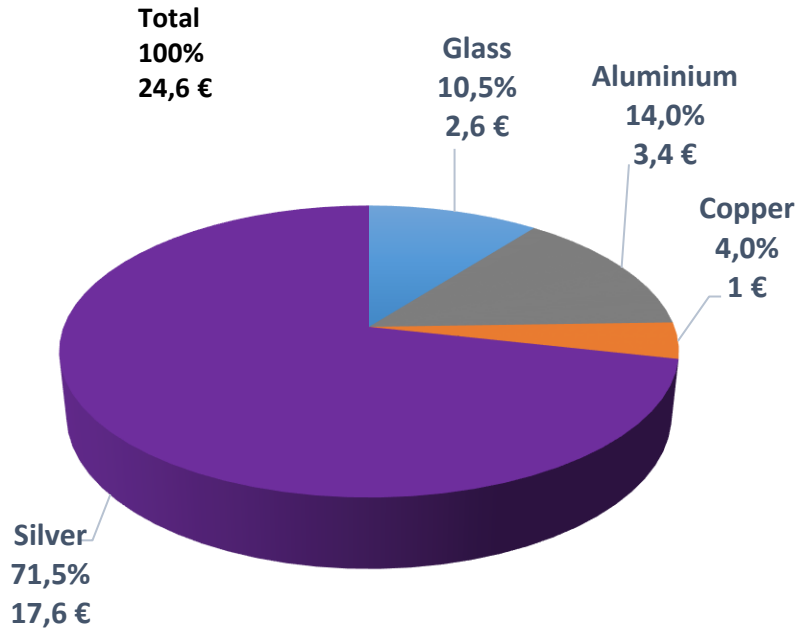
- Currently high amounts of stored, destroyed solar cells
  - Mainly stored in Italy

Composition of mass and value

Mass fraction per module



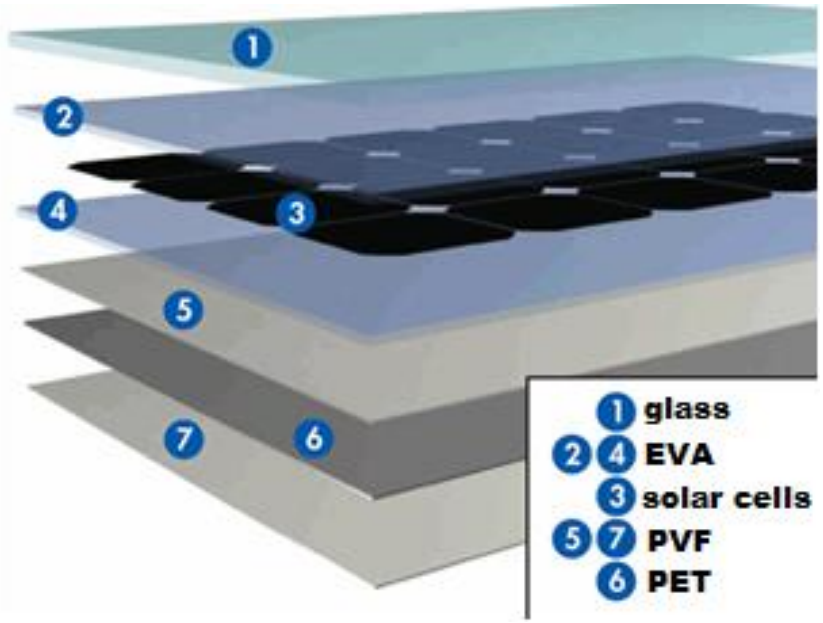
Value per module



Recycling Challenge: Polymers

POLYMERS…

- agglutinate the modules
- make mechanical treatment difficult
- Have to be removed

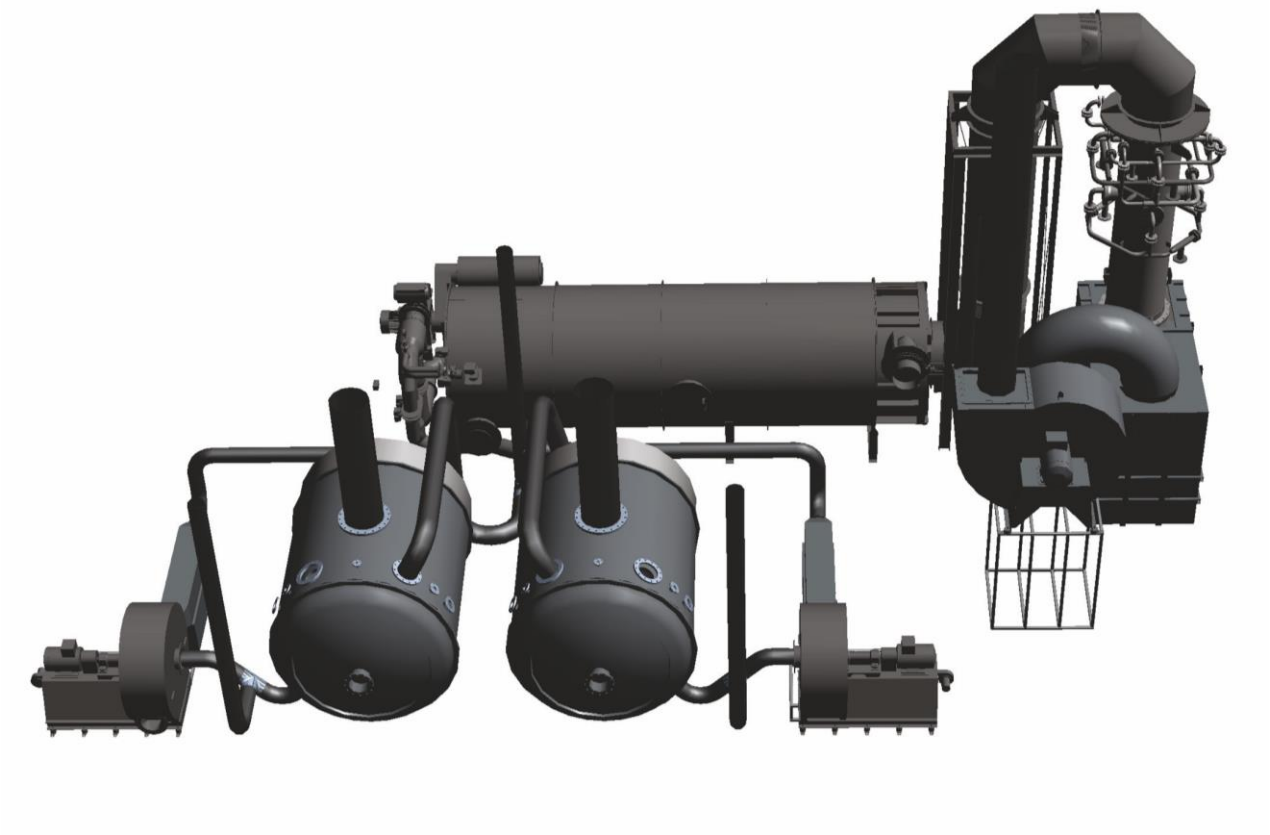


Pyrolysis

- „burning“ without oxygen
- Cracks the bonds in polymers
  - Polymers become gases like methan, ethan, propan…

Temperature	H_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_6	C_3H_8	i-Butan	n-Butan
280-350 °C	3	15,2	68,7	9,2	0,8	0,5	0,7	0,4	1,2	0,3
> 400 °C	3,4	18,3	14,9	2,4	15,2	15,9	15,5	10	0,2	4,2

Pyrolysis-Plant



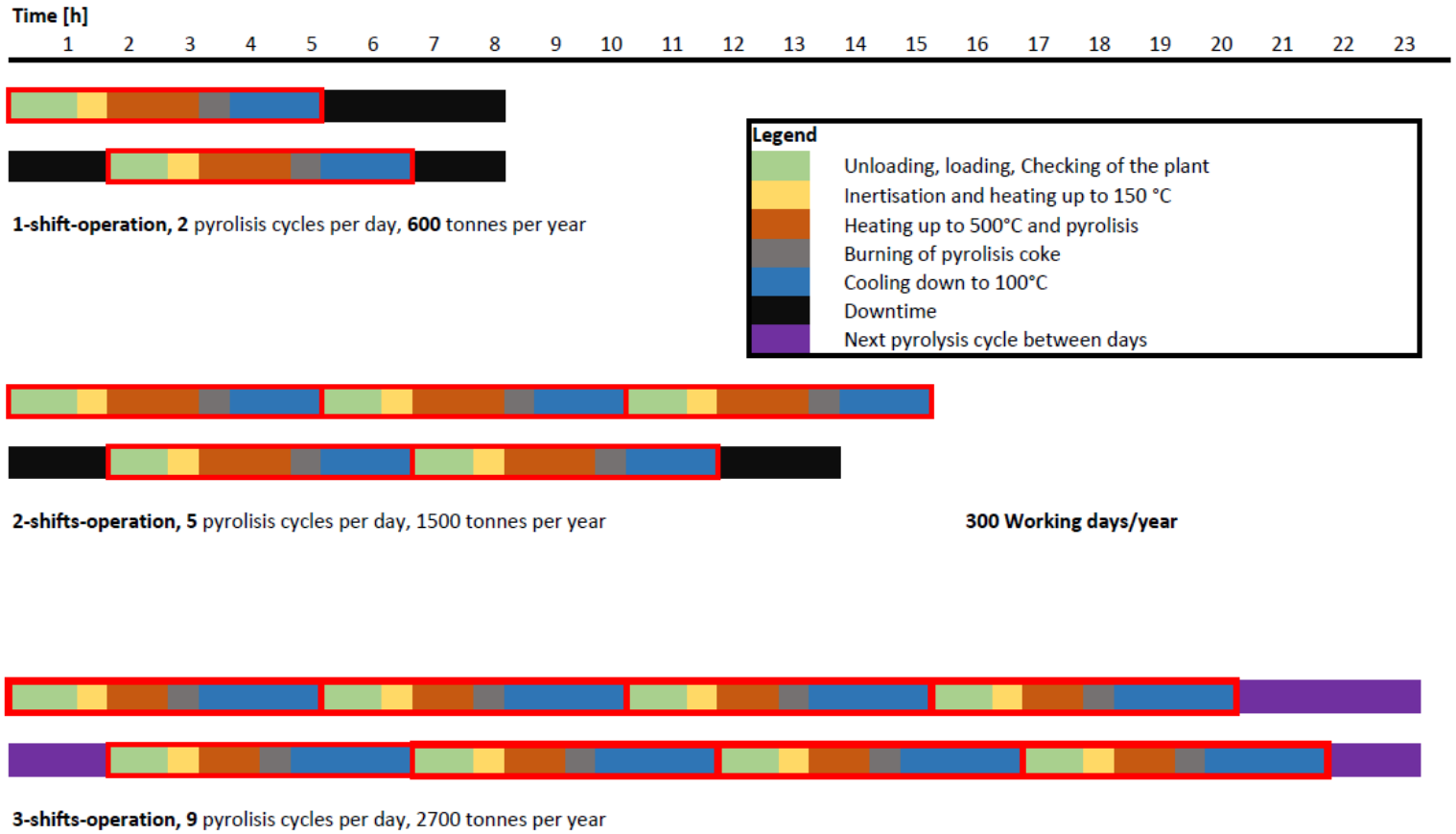
Reactor

- Process in nitrogen atmosphere
  - Oxygen free
- Heating up to 500 °C
- Exothermal Pyrolysis starting at 350 °C
- Safety measures
  - Rupture disc
  - 3x redundant O_2-measurement
  - Safety burner

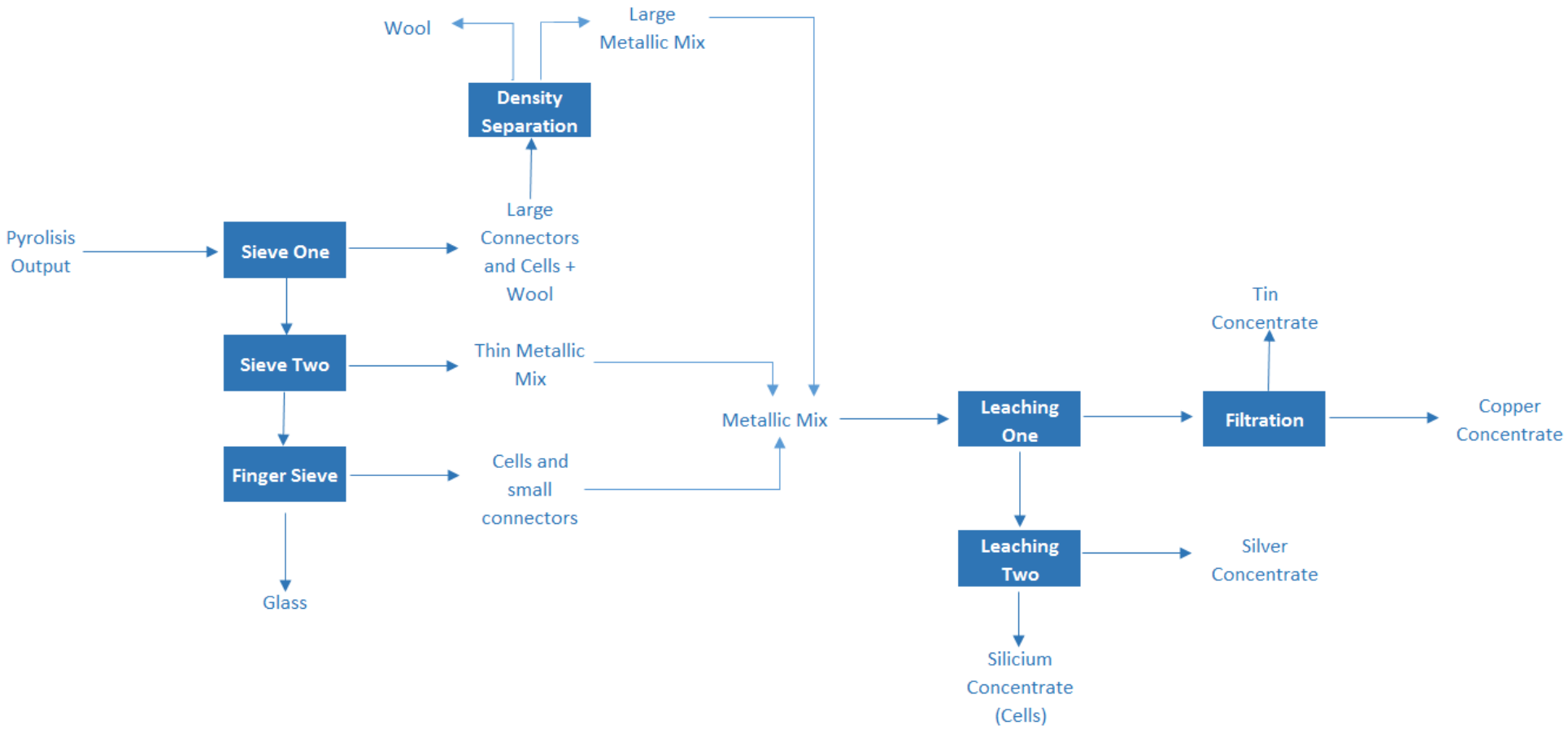
Exhaust gas treatment

- Afterburning at 850 °C for 2 s
  - Burning of pyrolysis gasses
  - Destroying dioxines
- Hot gas quench
  - Rapid cooling from 500 °C to 80 °C
  - Prevention of de-novo-synthesis of Dioxines

Capacity of the Pyrolysis process



Material Recovery



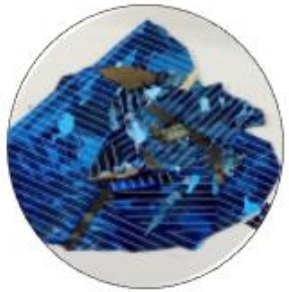
Recycling of materials

- Per tonne solar modules

	Masse (kg)	Main Element	Element of value	Material Value (€)
Frame	100	Al	Al (1,5€/kg)	150
Polymer	100	PVB	none	
Glass	750	SiO2	none	
Glass Wool	2	SiO2	none	
Cells	43	Ag (2%), Al (15%), Si (90%)	Ag (480€/kg)	415
Connectors	5	Ag (4%), Cu (80%), Sn (10%)	Ag (480€/kg), Cu (5,7€/kg), Sn (17,6€/kg)	125

Glass

Glass Wool



Cells

Connectors

Further steps

- Building up second reactor
  - Higher capacity
  - Heat recovery
- New plant with continuous process
  - Continuous pyrolysis furnace
  - Much smaller exhaust gas treatment
  - Much better energy efficiency due to full utilisation of exothermal process

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