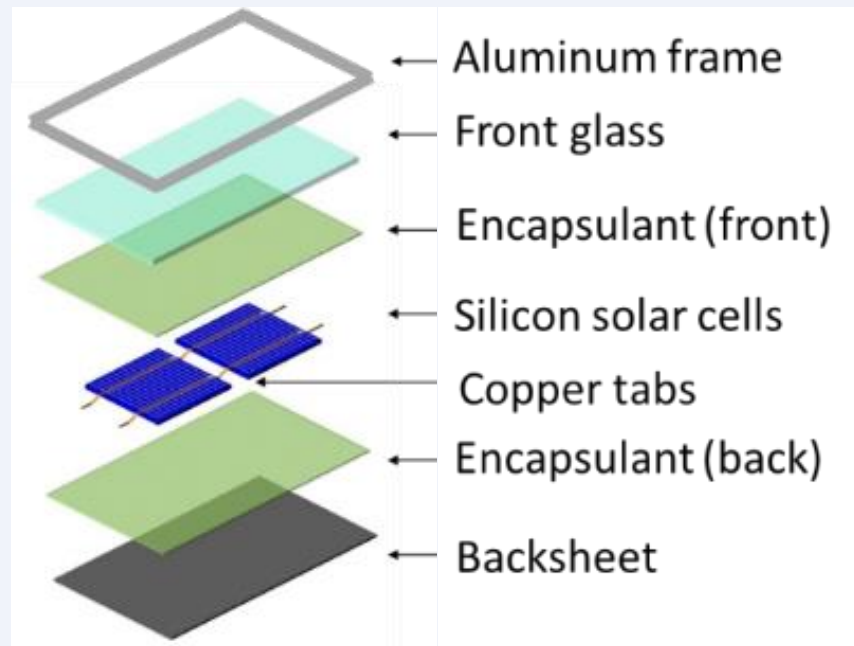


PV panelen en kritieke materialen (CRMs)

Frank Lenzmann
TNO - Energy & Materials Transition
frank.lenzmann@tno.nl

Samenstelling materialen PV paneel

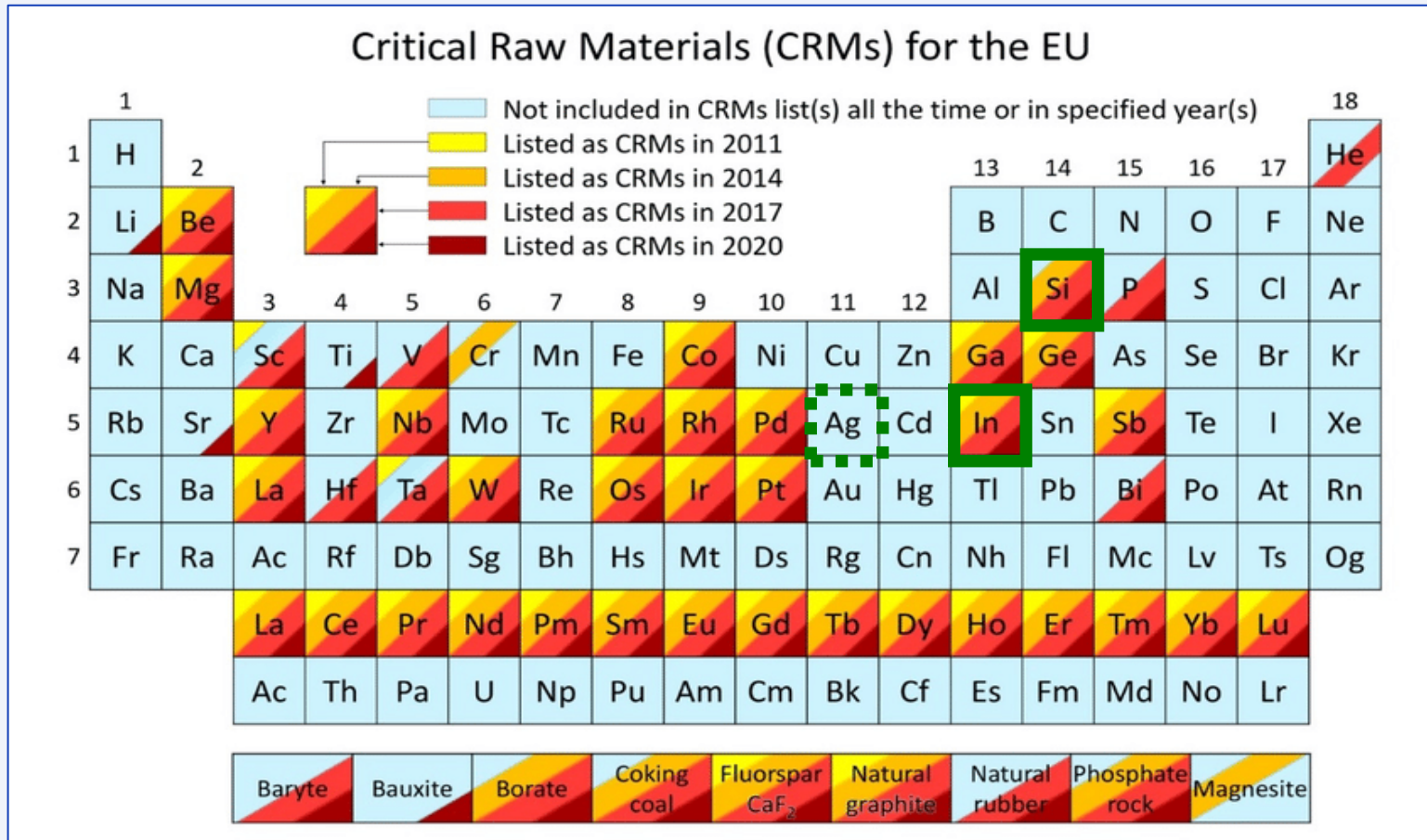


*Typical PV module from the production period of ~ 2010 – 2015
60 cells, ~ 300 Wp*

Material	Mass (kg)
Glass (front pane)	14
Aluminium (frame)	3,6
Polymers (encapsulant and backsheet)	1,3
Silicon (solar cell wafers)	0,7
Copper (internal and external wiring)	0,2
Silver (internal electric contacts)	0,01

Total ~ 20 kg

Kritieke materialen (CRMs)

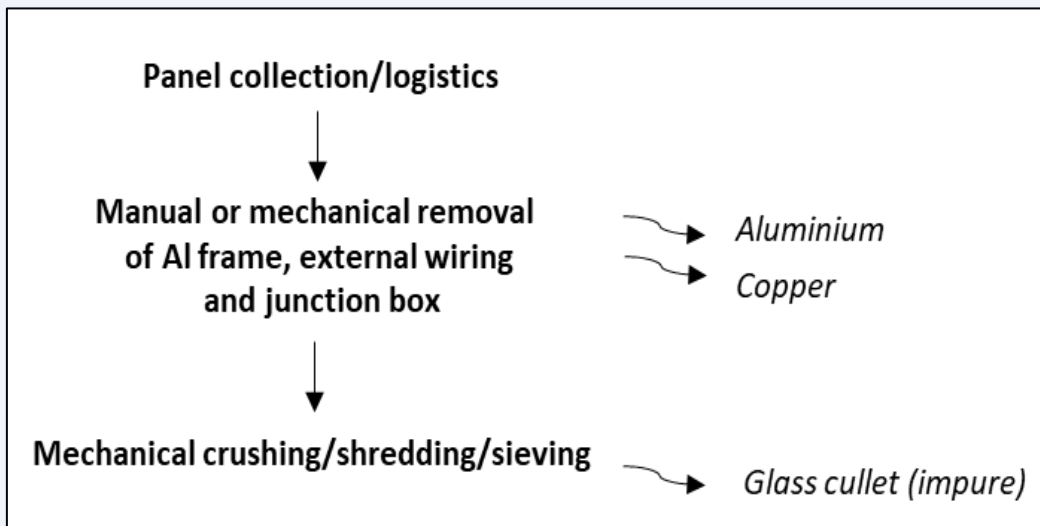


https://www.researchgate.net/figure/Critical-raw-materials-list-for-2011-2020-overlaid-on-the-periodic-table-of-elements_fig1_349058168

PV recycling > focus op zilver en silicium

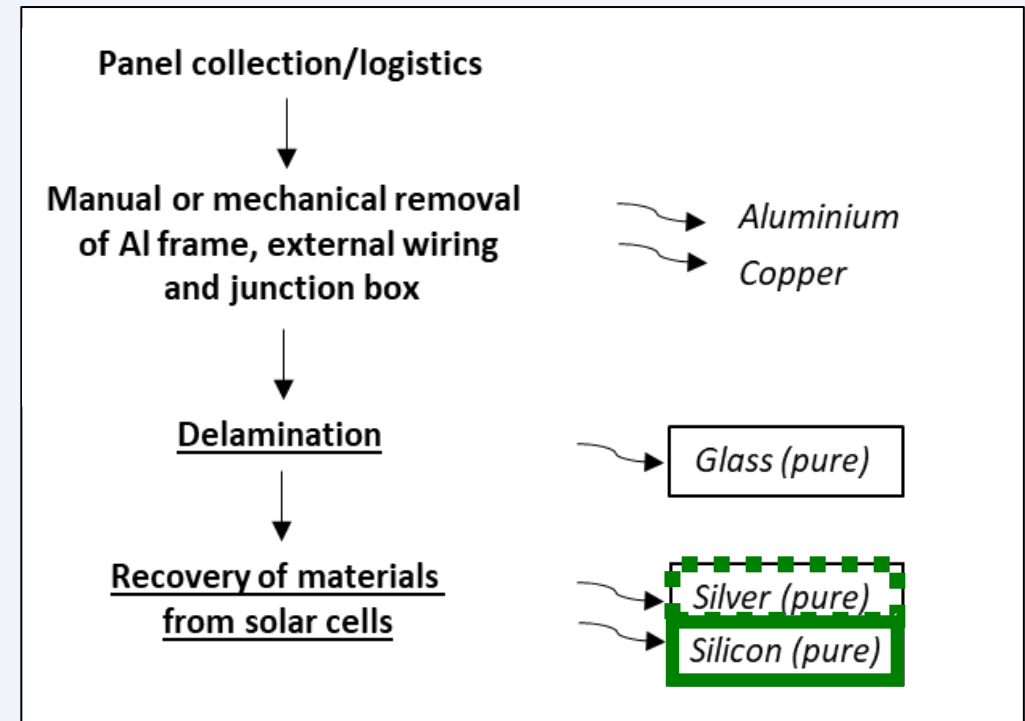
Hedendaags

Recycling van zilver and silicium: **NEE**



Toekomst (in ontwikkeling)

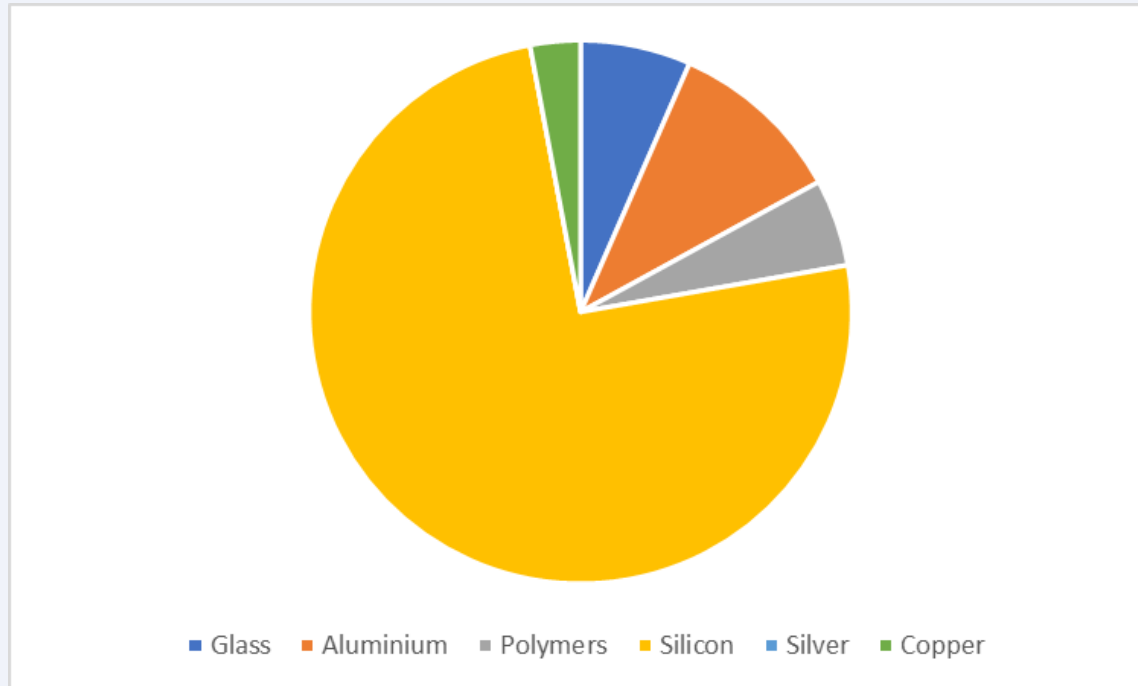
Recycling van zilver en silicium: **JA**



CO2 voetafdruk: silicium (solar-grade*) dominant

* Purity $\geq 99,9999\%$

Typical PV module from the production period of ~ 2010 – 2015
60 cells, ~ 300 Wp

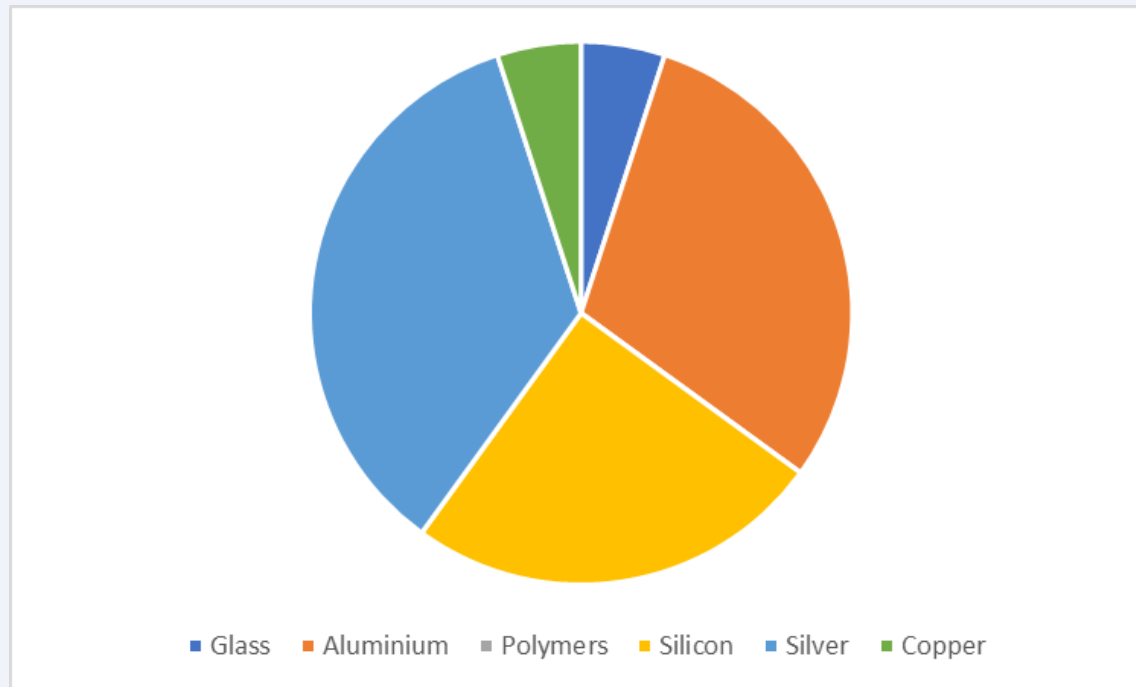


Totaal

~ 350 kg CO2-eq./module;
~ 1170 kg CO2-eq/kWp

Economische waarde EoL: Ag, Si en Al dominant

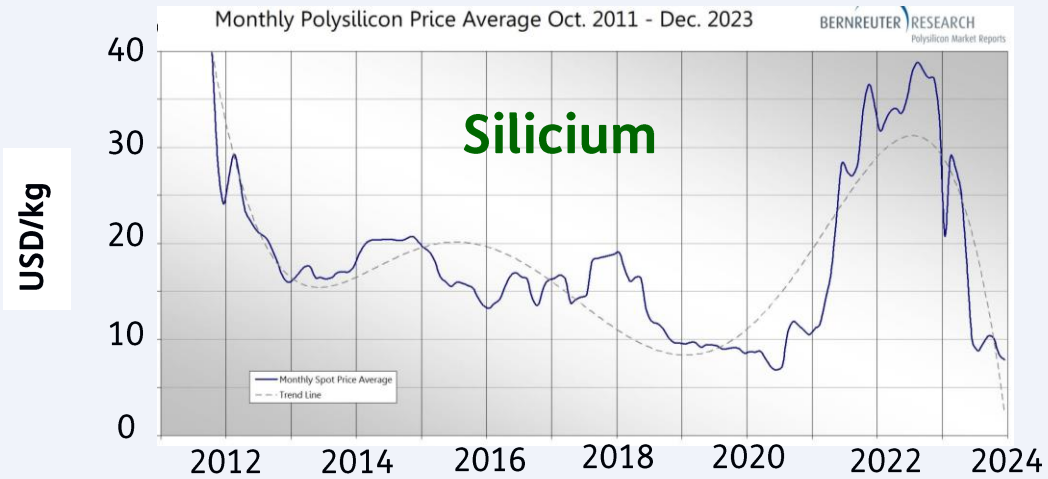
Typical PV module from the production period of ~ 2010 – 2015
60 cells, ~ 300 Wp



Totaal

~ 12 €/module;
~ 40 €/kWp

Prijsfluctuaties (silicium en zilver)



Industriële initiatieven PV recycling (in EU)

In samenwerking met publieke R&D organisaties

ROSI Solar/CEA (Frankrijk)

Beperkte informatie gepubliceerd in PV Magazine:

- Delaminatie via pyrolyse, chemische opwerking, capaciteit tot 3000 t per annum
- > Puur solar glas (zonder verontreinigingen), Al, Cu, pure CRM's (Ag, Si)

Reilling/Fraunhofer (Duitsland)

Beperkte informatie via de pers

- Delaminatie via mechanische processen gevolgd van sortering, industriële schaal beoogd
- > Glas, Al, Cu, onduidelijkheid over CRM's (Ag, Si)

Resilicon/Fraunhofer (EU, gevestigd in Nederland) > presentatie Jacques Mikx