JBR Recovery Ltd

Incineration : Smelting : Refining

JBR
Refining Since 1760

The importance of efficiently recycling spent PV solar panels

Lee M Hockey – 14th November 2023

Agenda

- Introduction to JBR Recovery Ltd
- Energy production and PV solar panel’s role in global decarbonisation
- Make up of a PV solar panel
- Silver market overview and Silver in PV solar panels
- Current PV solar panel recycling
- Future processing options and company activities
- Horizon - EVERPR Project - Consortium
- Conclusion

Introduction to JBR Recovery Ltd

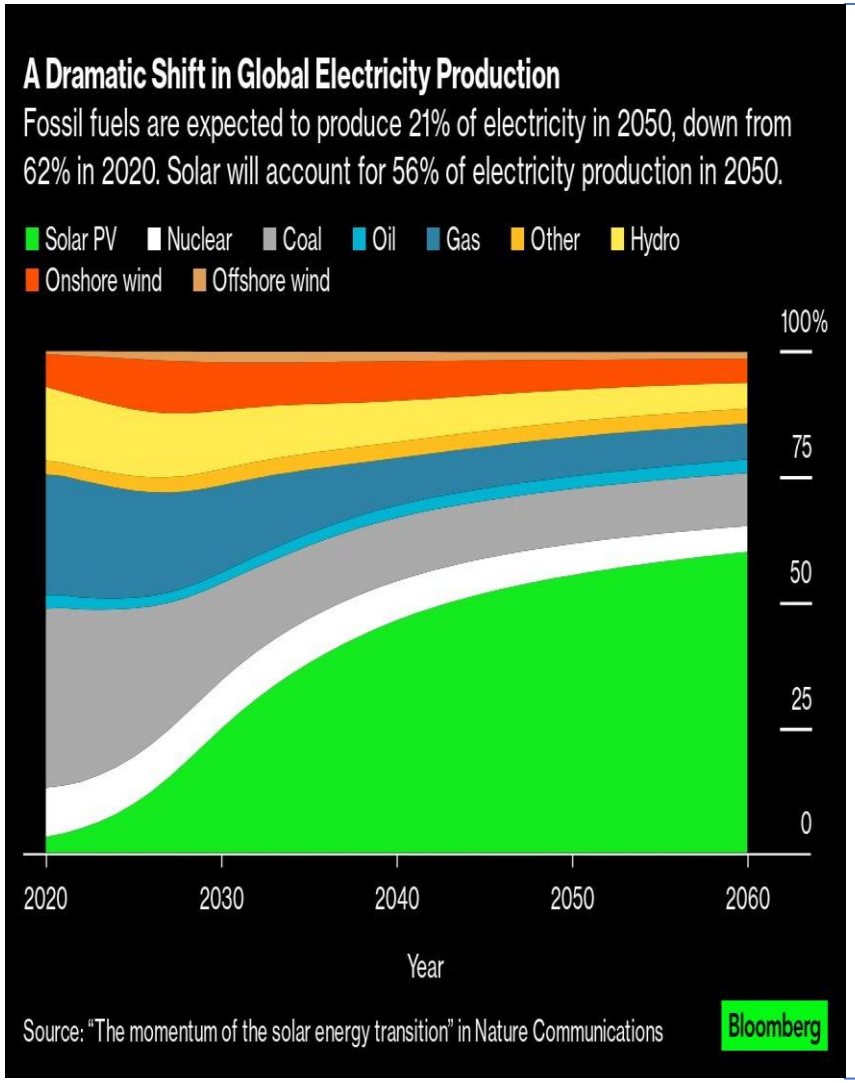
Background

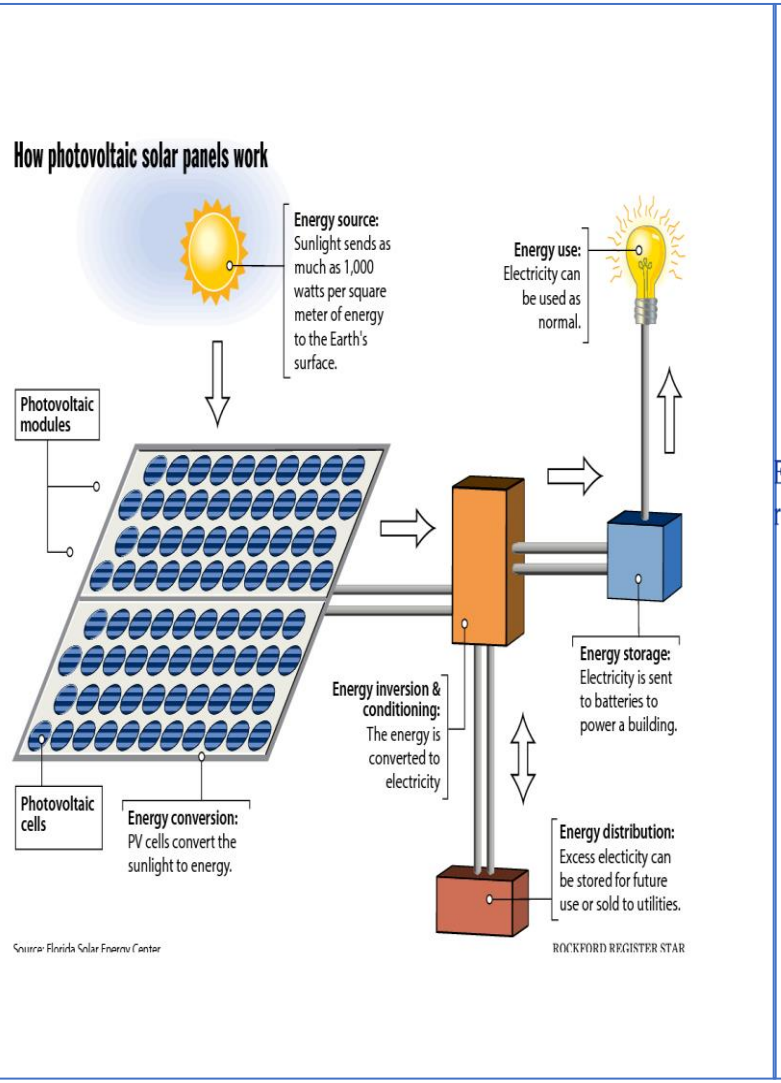
- Over 260 years History of smelting and refining of precious metals in the UK
- Member of the LBMA with Ag outputs having London Good Delivery status
- Can process various materials, in many forms and grades containing Gold, **Silver**, Platinum and Palladium
- Only secondary Ag only refiner that refines **Ag ONLY from secondary sources ie Green Silver**
- Refined and produced ~ 50 M ozs Good Deliver Silver in 2022
- Fully permitted site with EA permit number BJ9878 and hazardous waste registration NIB077
- ISO 14001 Environment Management System
- Fully secured site with 24/7 manned security and high value vault
- Members of the LBMA, IPMI and the Silver Institute with a global customer base and from many market sector
- **Can now SUPPLY 999 and 9999 LGD market bars and 999 and 9999 Silver Grain**

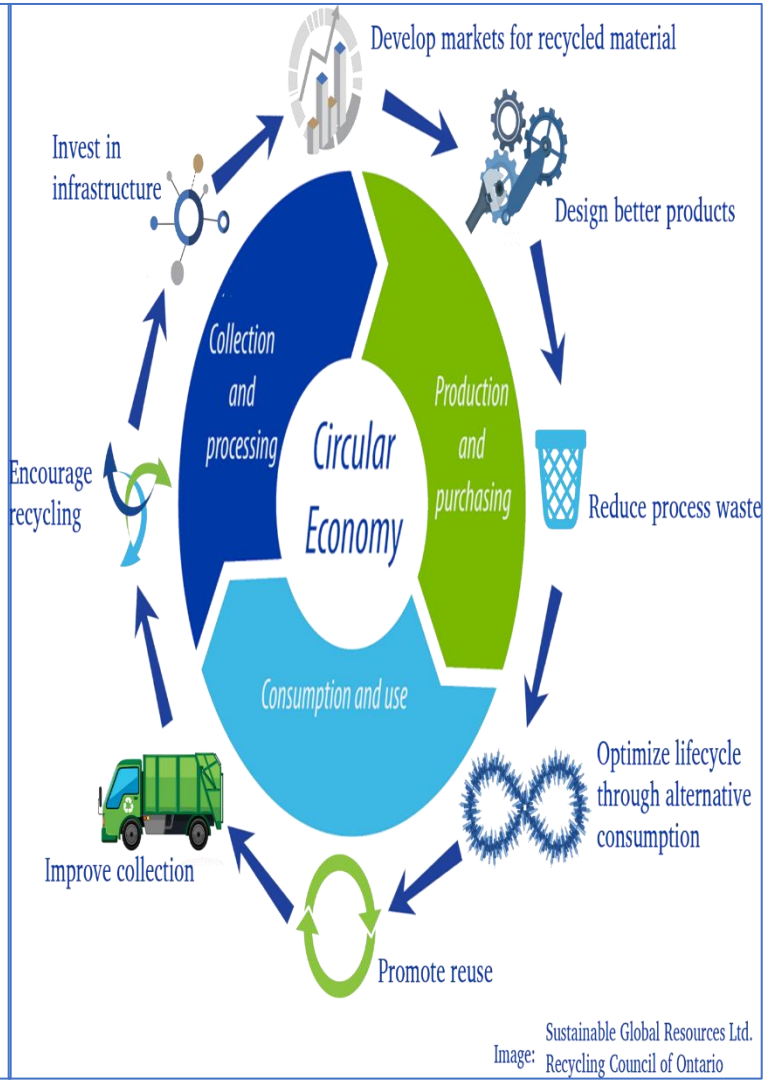
Materials Refined

Photographic	Industrial film, medical x-rays, rolls, paper, emulsions, water treatment sludges, fixer solutions, recovery residues
Electronics	Circuit boards, pastes, pots, inks, manufacturing rejects, MLCC's, impregnated wipes, ceramic substrates, targets, batteries
High Grade	Dore, jewelry, coins, bars, bullion, non good delivery bar conversion, grain, flakes
Others	EO Catalysts, other industrial catalyst, Ag Chlorides, litharge's, Lead wastes, solar panel wastes, sweeps & residues

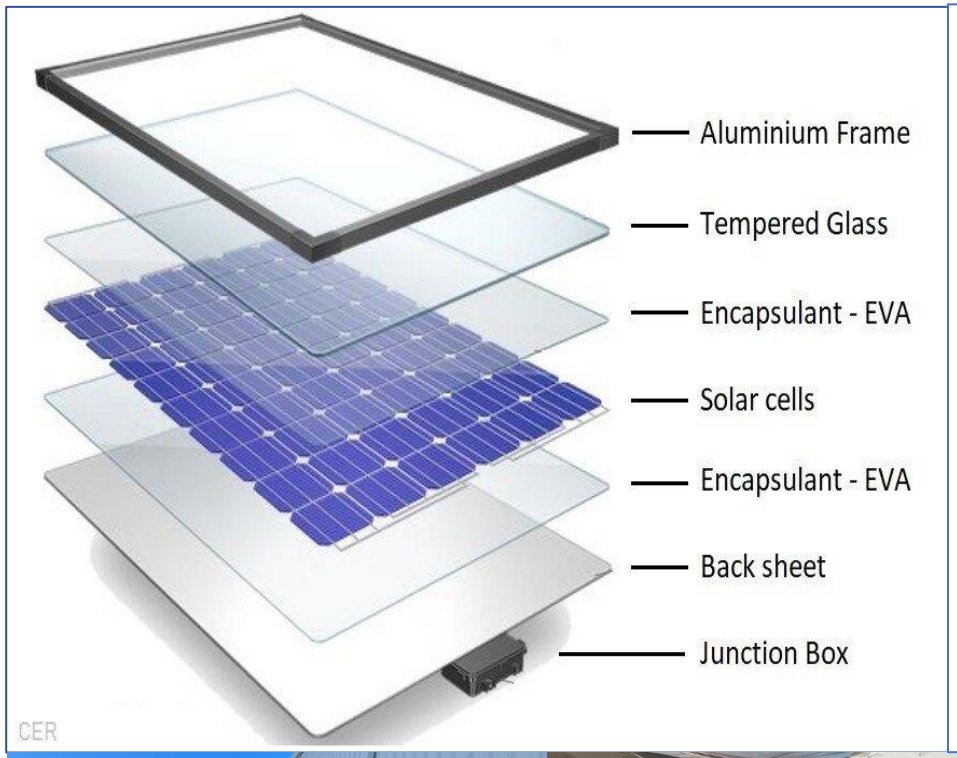
Energy production and PV solar panel's role in decarbonisation

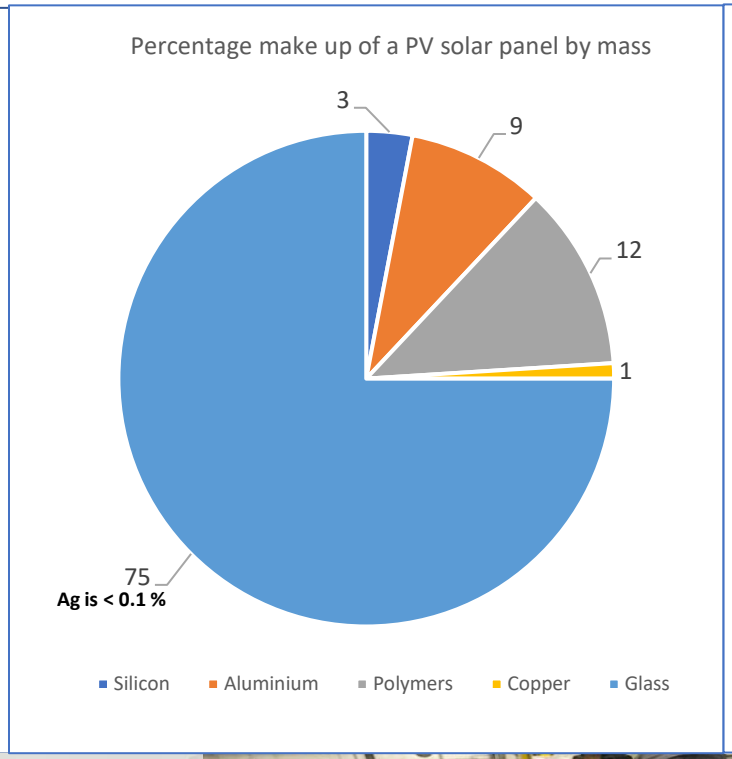


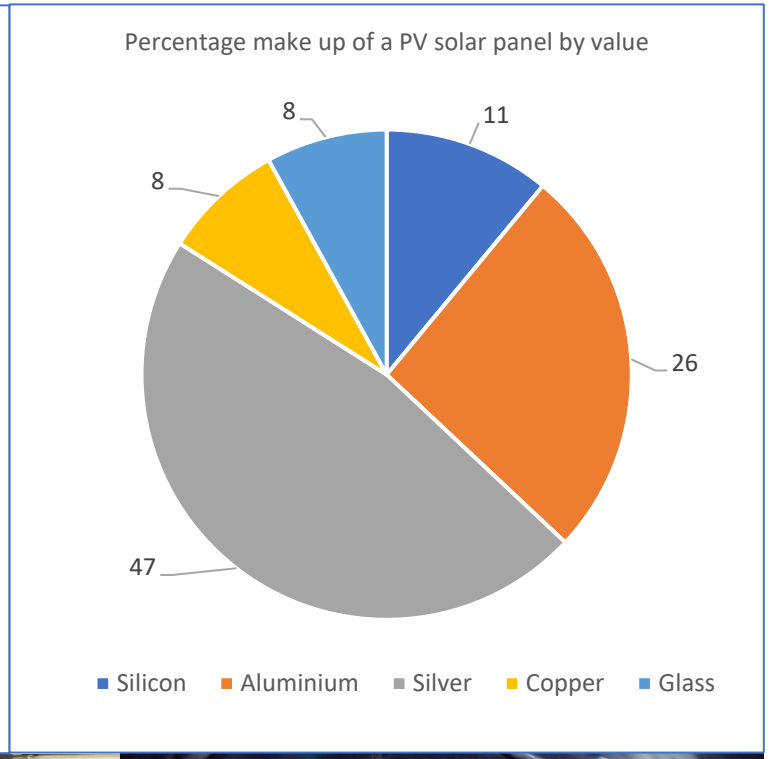


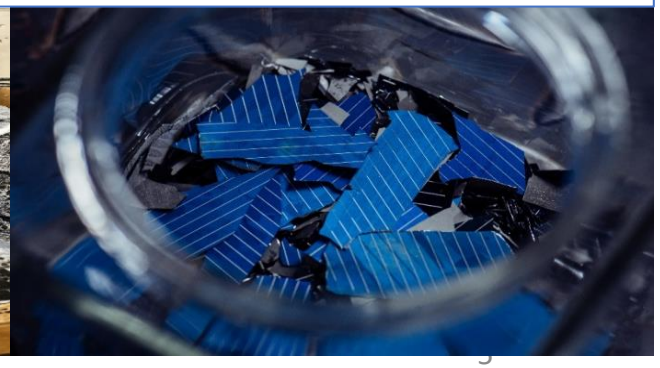


Make up of a PV solar panel

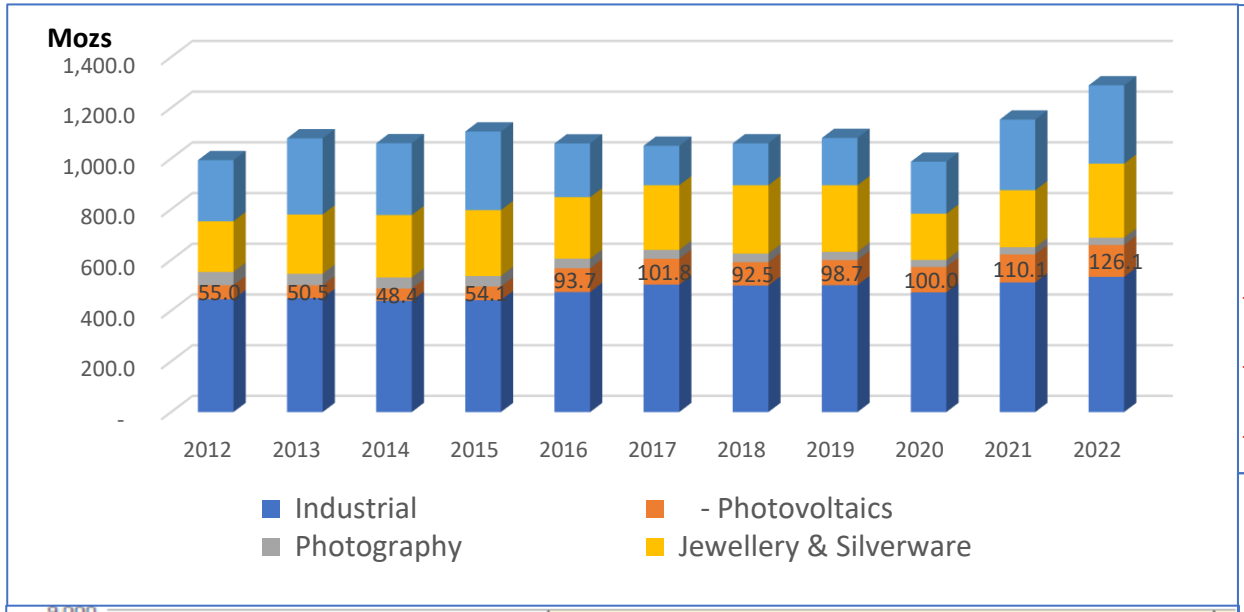


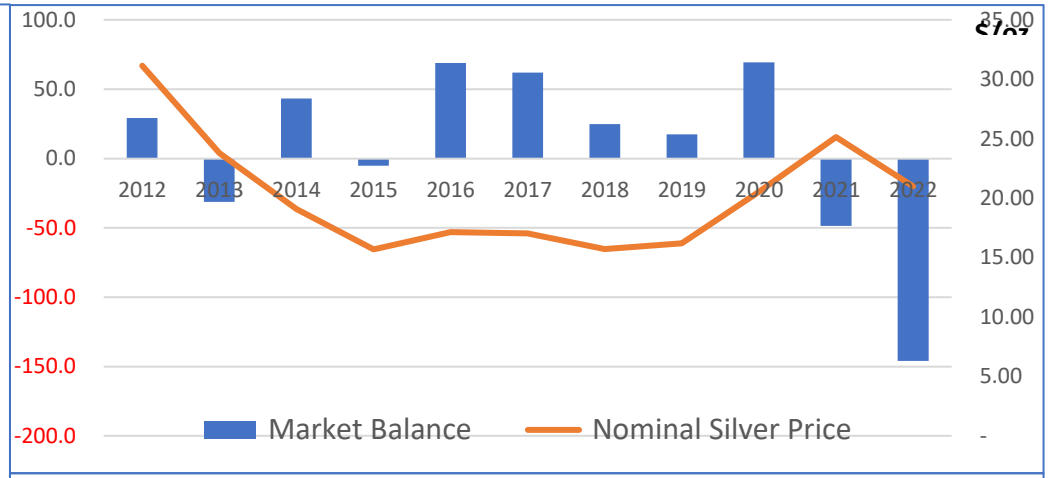


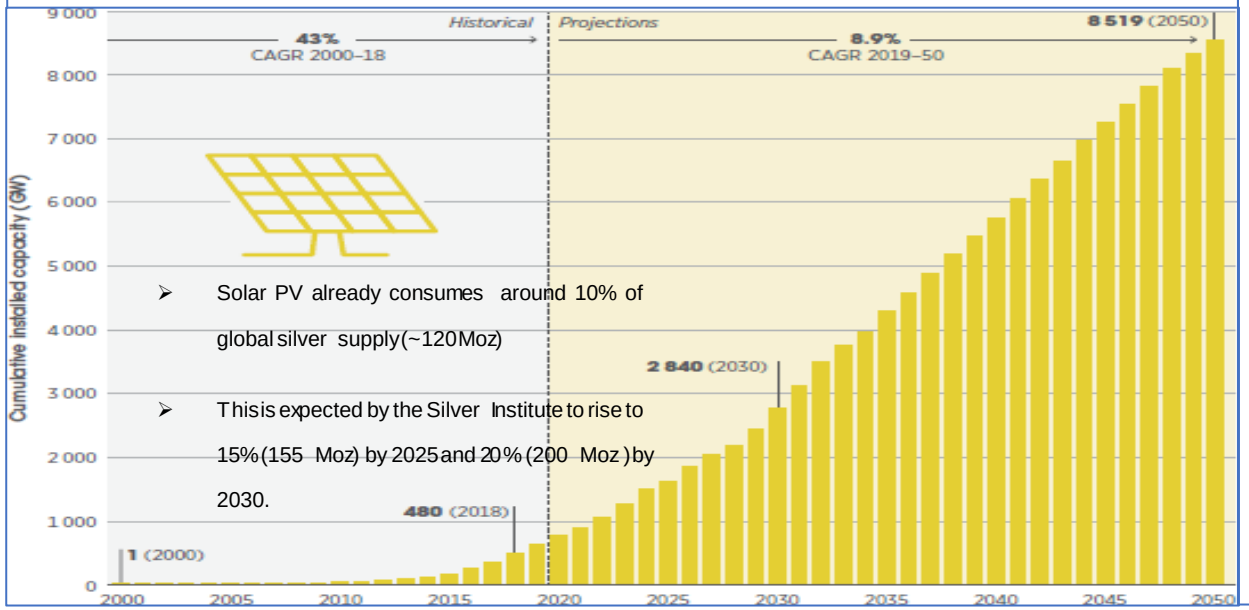




Silver market overview – Ag in PV solar panels







Commentary

- Current Silver market is in a structural deficit but it is supported by significant above ground stocks
- Silver demand within the PV solar panel market continues to be strong with ~100 M oz's fresh Silver demand per year growing to 200 M ozs by 2030, current Silver installed in PV solar panels is over 1 B oz's
- There is continued thrifting of Silver in 2000 loading was 0.18 gm/watt current loadings are 0.02 gm/watt
- Silver is less than 0.1 % of the weight of a solar panel but 47 % of the value
- Current installed capacity is ~ 1,000 GW which equates to > 1 M solar panels. General life of a solar panel is 25 years before it loses its efficiency

Current PV solar panel recycling

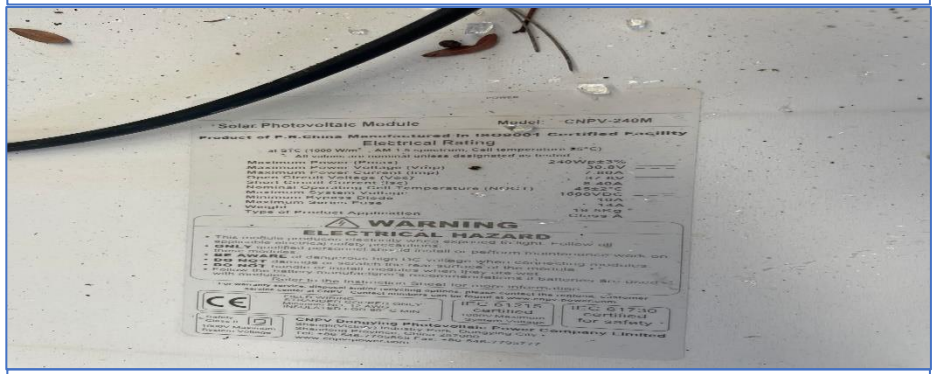
PV Solar Panels Materials of construction

- Aluminium framing — *Recoverable*
- Glass — *Non recoverable*
- Silver — *Recoverable*
- Copper — *Recoverable*

Current Market Dynamics

- Material currently mainly landfilled
- Starting to see (15 years) first panel recalls / change overs
- Earlier solar panels are much richer in Silver
- Aluminium framing is already a $5 billion per year business
- Grades of Silver vary (after Aluminium) removal
  - Shredded panels 0.25 – 0.5 % Ag
  - Wafers after removal of silica panels 0.5-1.0 % Ag
- Some early players, mainly in US for whole panels, wafers can be refined by many precious metal refiners

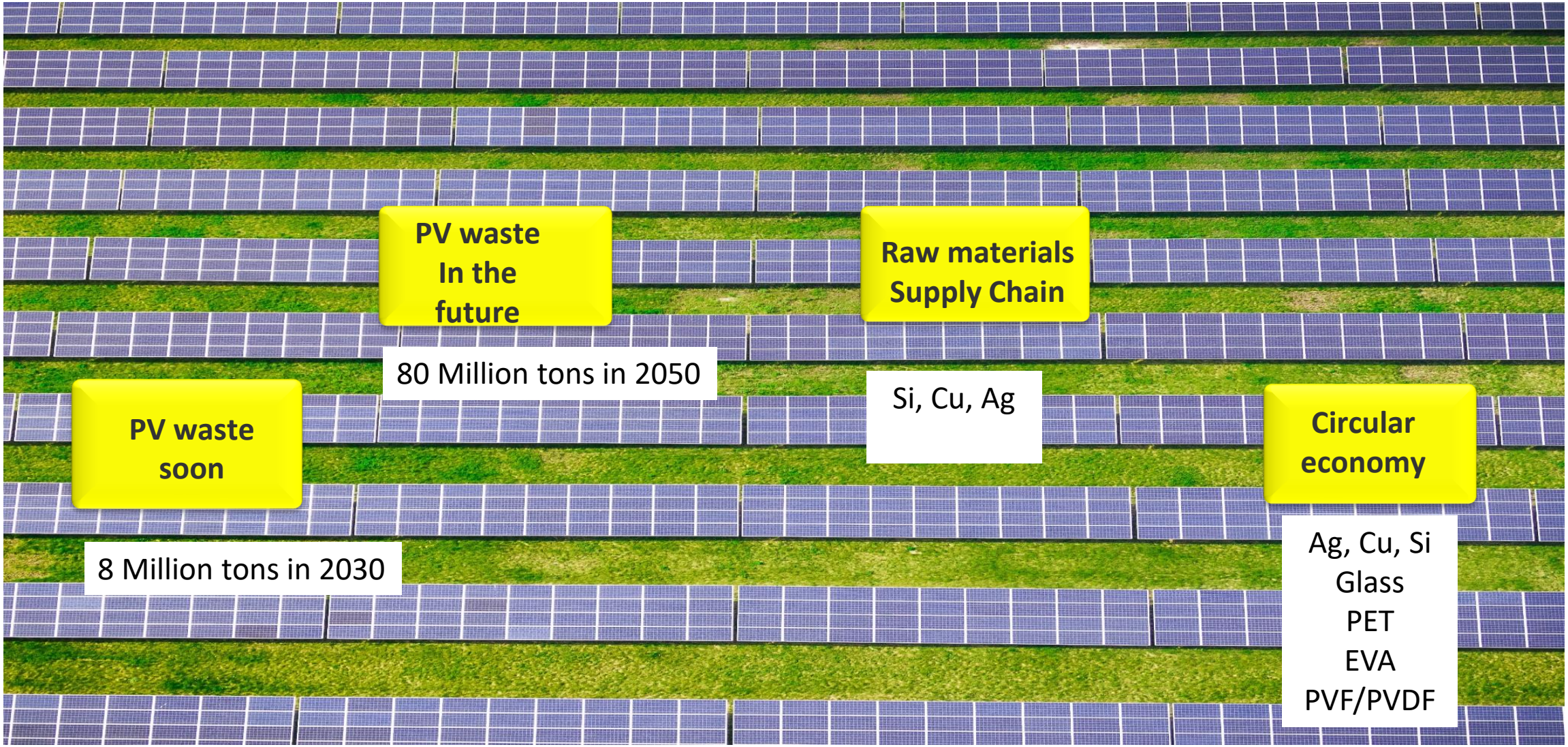
Currently treated same as e scrap in terms of licences and shipments



Most panels are landfilled and are charged to be disposed of

Type	€/Ton
With alumina frames	160€
W/out alumina frames	300€
Amorph	350€
CIS (Copper Indium Selenium)	400€
CCS (carbon capture storage)	450€
Tellurium Cadmium	500€

Future processing options and company activities



Future Processing Options and company activities

Current Processing

- Material appears to be entering EOL supply chain via the same channels as e scrap
- ~ 50 companies said to be active in solar panel recycling (18 Europe, 12 USA, 5 Australia)
- Company types appear be PV manufacturers, e scrap collectors, specific PV recyclers and waste companies
- Limited entrance by precious metal companies (mainly wafers)

Patents

- 15 patents filed for PV Recycling
- 10 patents are ex China and all Universities or Institutes

New projects (looking to recover other elements and streamline the processing) being set up some with EU funding

- Rosi Solar with Envie, Soren, Flaxres, Evonik (Germany)
- Photorama with Enea, Enel Green Power (Italy)
- Everpv see next slide (France)

Other companies

First Solar (USA)
Renewi (Belgium)
Solar Cycle (USA)
Ademe (France)
WeRecle Solar Inc (USA)
Suny Group (China)

Conclusion

- Global climate change is driving the world to energy transition, decarbonization and a circular economy
- Solar power will produce over 50 % electricity by 2050
- Silver demand within the PV solar panel market continues to be strong with ~1 M ozs fresh Silver demand per year with an installed capacity of over 1 B ozs Silver
- We are starting to see thrifting of Silver within new modules to try to limit fresh Silver demand as GW demand continues to grow
- Given a general life cycle of a solar panel being 25 years there could be as much as 8 M mt's of panels to recycle by 2030 and 80 M mt's by 2050
- Recovery of all critical materials (Ag, Cu, Silicon) rather than land fill are crucial to make the above happen
- We are starting to see material available for recycling but mainly being landfilled which is not politically of economically efficient
- There are a growing number of players within the recycling, mainly waste companies or PV related companies with a small number recovering the Silver
- It will be crucial that this number grow's and projects related to recovering all elements succeed to ensure we manage the major growth in this sector and the supply / demand for Silver
- Timing will be crucial !

JBR Recovery Ltd

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Please take a look at our website for further information about the company and detailed descriptions of our processes:

www.jbr.co.uk

JBR Recovery Ltd

Argentor House, Oldbury Road

West Bromwich, B70 9BS

Phone : +44 (0) 121 525 1691