# Advancing the Circular Economy for Renewable Technologies: Regulatory Innovations for PV Solar Recycling in the Asia-Pacific Region

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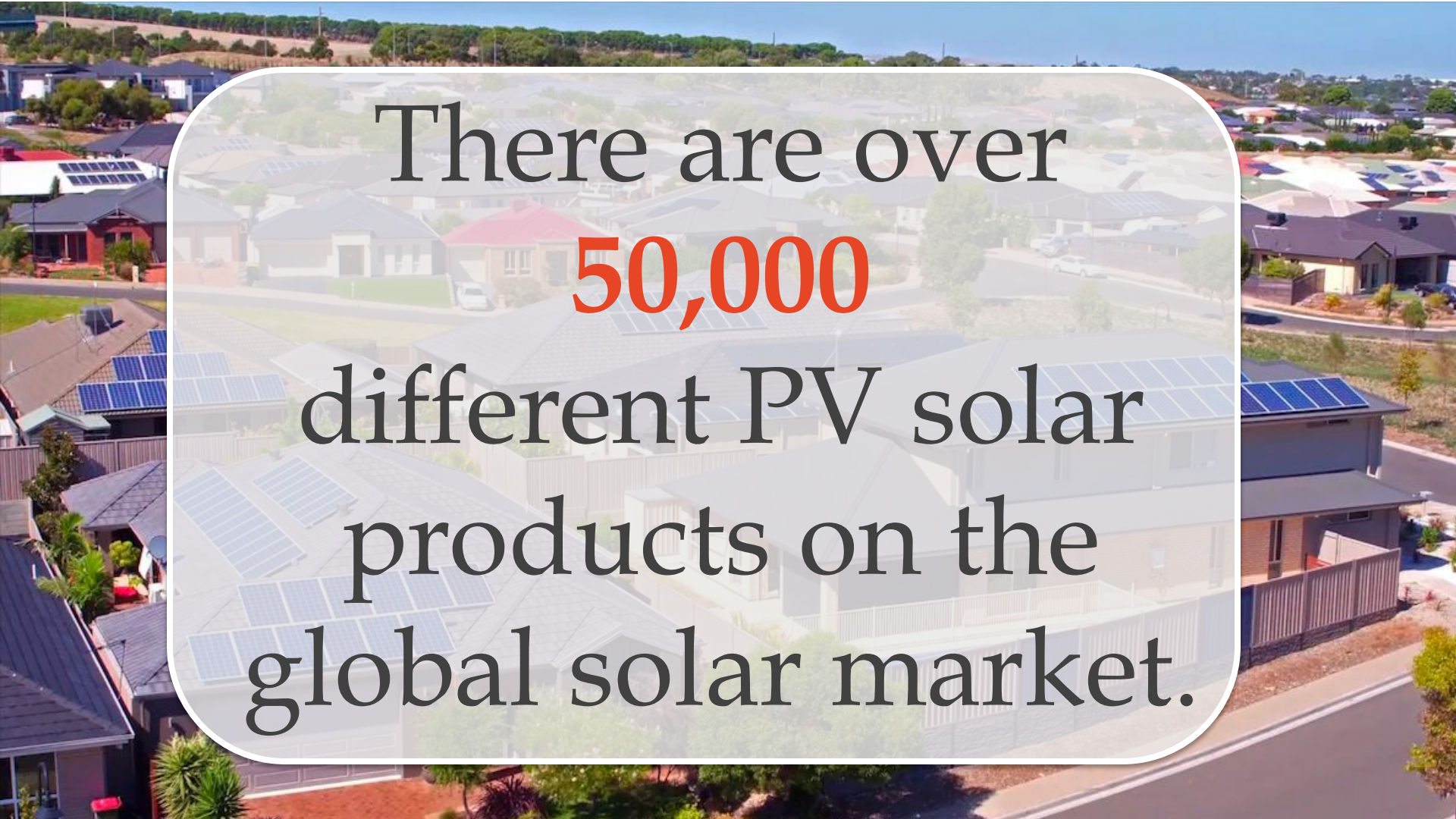
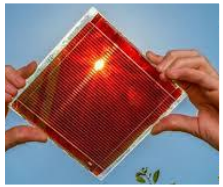
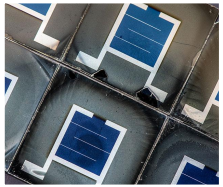

There are over
50,000
different PV solar
products on the
global solar market.

# Recent solar innovations

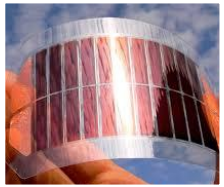


Peroskovite Solar Panels



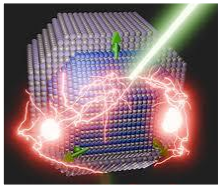
Tandem Solar Cells

Bifacial Solar Cells

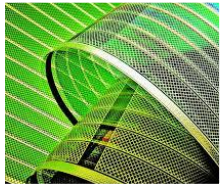


Organic Solar Cells

Building Integrated Photovoltaics

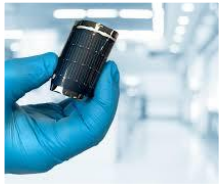


Quantum Dots

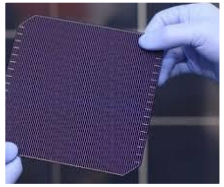


Organic Polymers

TOPCon Technology

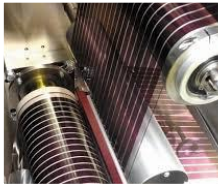


CIGS



Graphene

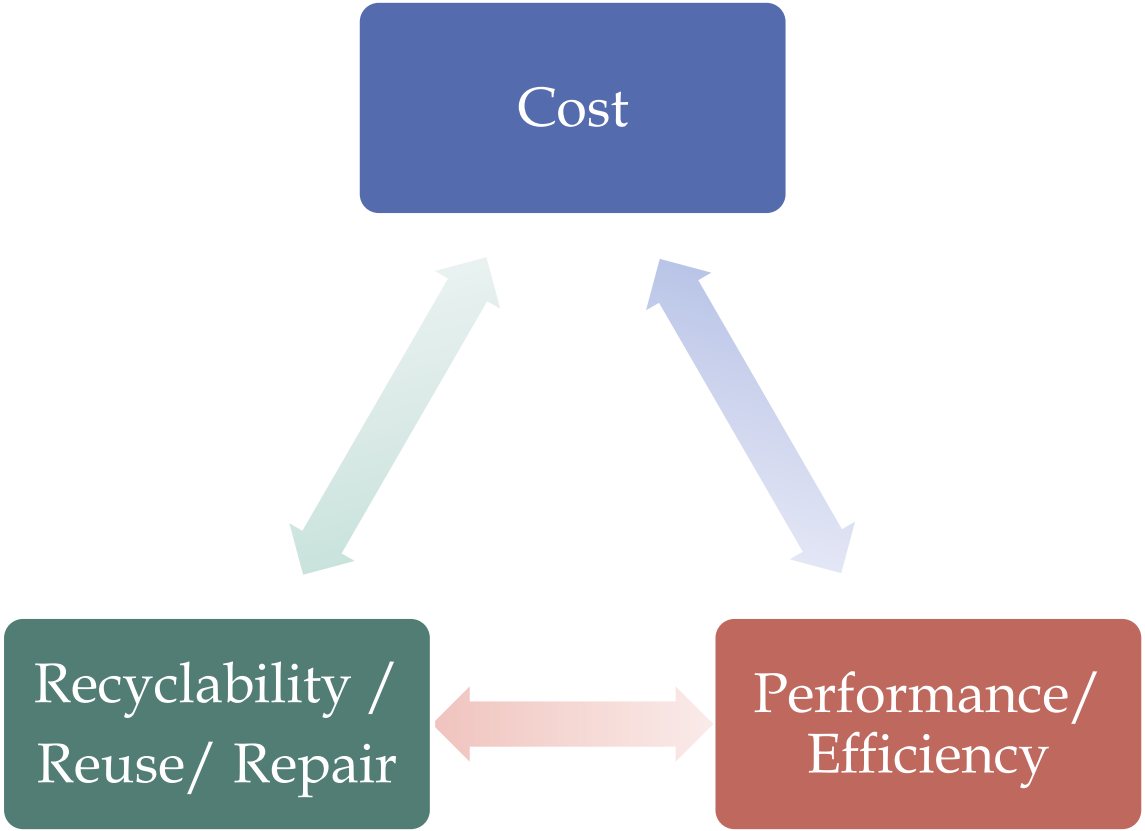
Sun-Tracking Solar Panels



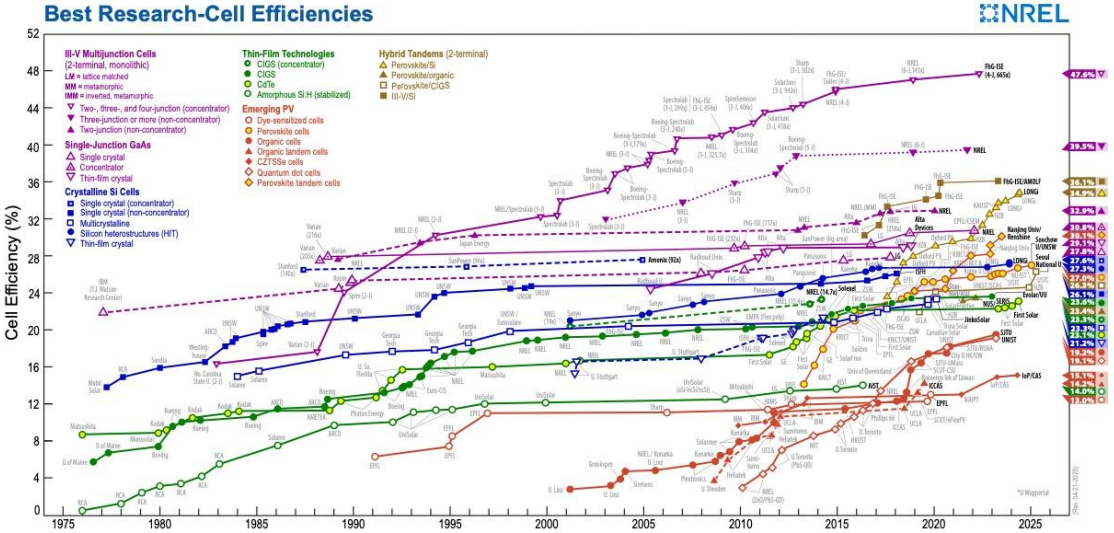
Printable Solar Cells

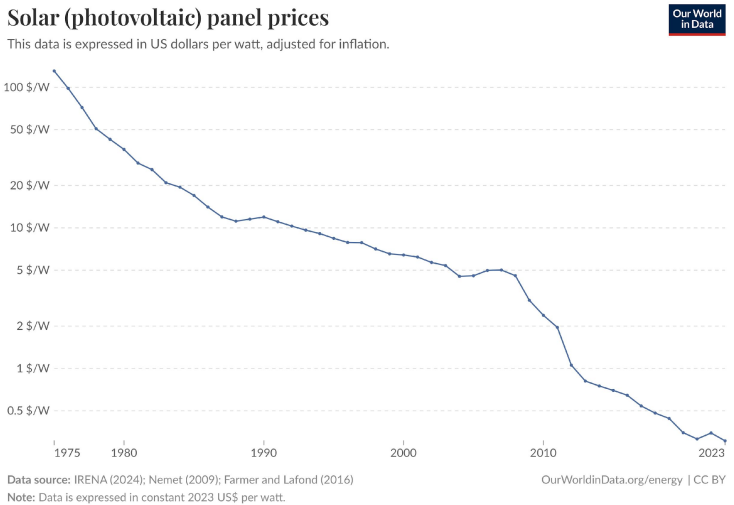
Solar Skins

# Design trade-offs in new solar innovations



# Focus of technological innovations

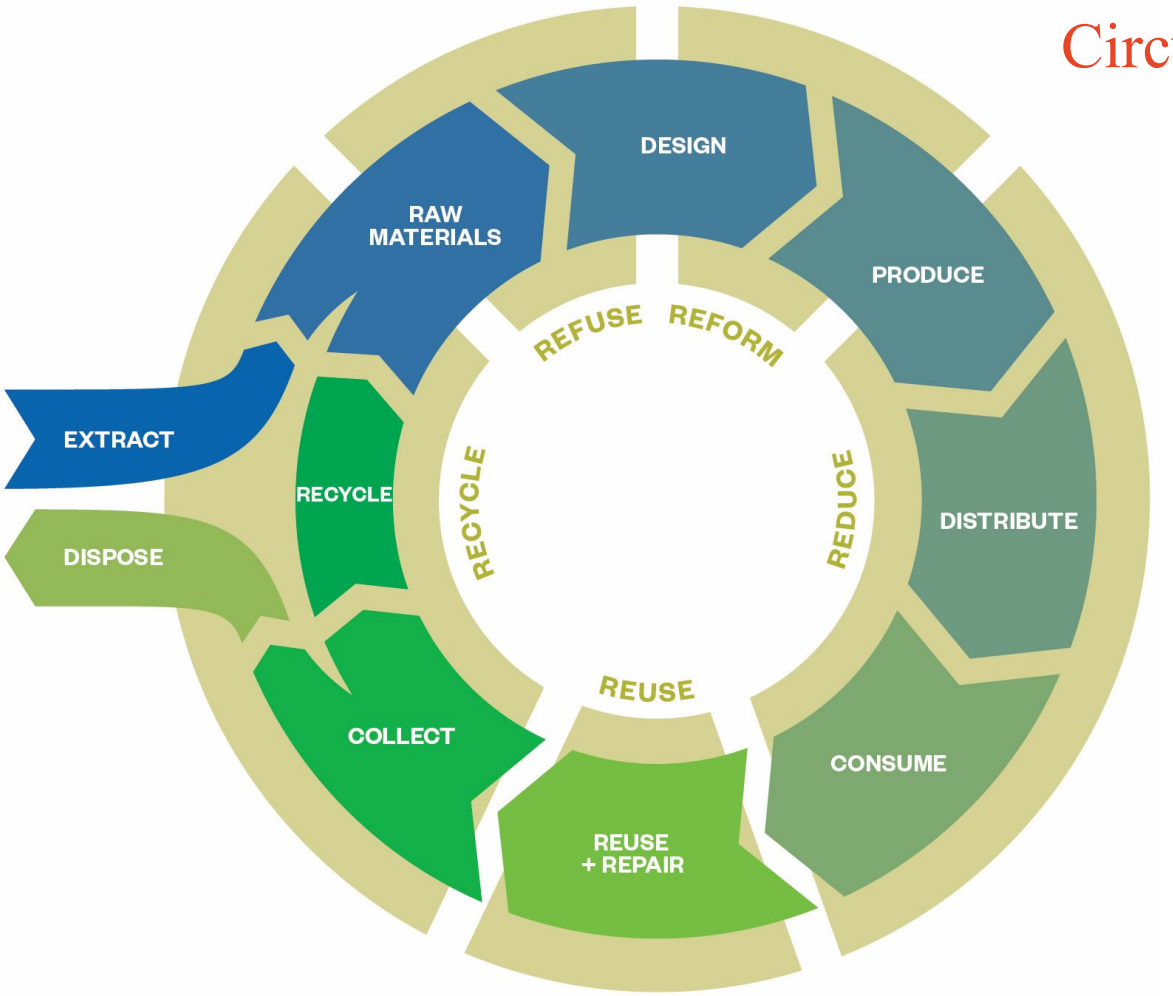


Currently, most PV solar products go to landfill at EoL rather than being reused/repaired/recycled.

Solar waste est. to create 78 million tonnes of toxic waste in landfill globally by 2050 (IRENA, 2016).

# Circular Economy



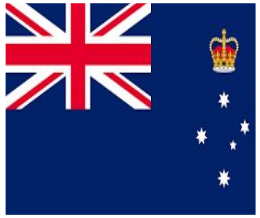
# 7 Fundamental challenges at EoL for Solar PV

- Fluctuating volumes of solar being retired (unpredictability due to early retirement)
- Lack of available data
- Need for economies of scale
- Diversity of products/lack of international product design standards
- Lack of available and affordable testing for 2nd hand market (reuse/repair)
- Lack of recycling facilities
- Cost of recycling + value of recycled materials vs cost of landfill

# Selected regulatory solutions

## European Union

Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE) (recast)



## Victoria, Australia

Environment Protection Act 1970


## California, USA

Photovoltaic modules (PV modules) – Universal Waste Management Regulations 2021

Hazardous Waste Control Law

## South Korea

Enforcement Decree of the Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles (Resource Circulation Act)

# Advantages and Disadvantages of Regulatory Options

| Regulatory option | Advantages | Disadvantages |
|---|---|---|
| Mandatory Extended Producer Responsibility | Creates market scale and should drive down cost | Increases upfront costs for consumers |
| Voluntary EPR | Provides marketing benefits for participants | Unlikely to capture most of the market |
| Landfill Bans | Prevent critical minerals and lead/cadmium going to landfill | Without recycling facilities, creates a long-term storage issue. |
| Mandatory Recycled Content Requirements | Provides a market for reprocessed PV solar materials | Difficult unless domestic solar PV manufacturing and recycling is at scale. |
| Incentivising Private Sector Participation | Create industry buy-in and domestic capability | Who pays? |
| Design Standards | More uniform processes for repair/recycling | May impede innovation and competition |
| Interoperability | Prevent early retirement of componentry | Lack of industry support |
| Testing Facilities | Urgently needed to support the repair/reuse market. | Hard to justify cost without government intervention unless sufficient scale/2nd hand market development |

# Circular clean energy regulation

A fundamental re-orientation of our regulatory framework governing renewable technologies to a holistic life cycle approach that encompasses the potential for recycling and critical mineral recovery at end of life, and principles of energy justice.

# Some key questions for legislative design

1. Who bears the legal onus to manage the end of life of renewable technologies and on what basis is that responsibility ascribed?

2. What ought regulation require the liable entity to do at the end of life?

3. How and when the mandated activities are funded?

4. What happens if the liable entity cannot recycle their renewable technology?

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