



Mining the module: Leveraging circularity for competitiveness and resilience

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05 February 2026

Impacting sustainable development at scale with data, integrated analysis, and strategic outreach

TRANSFORMATIONS

Low-carbon Economy

Energy Transitions

Power Markets

Industrial Sustainability

Sustainable Livelihoods

QUALITY OF LIFE

Clean Air

Sustainable Water

Sustainable Food Systems

Sustainable Cooling

Sustainable Mobility

ENABLERS

Sustainable Finance

Technology Futures

Circular Economy

Climate Resilience

International Cooperation

390+

Multidisciplinary team

550+

Peer-reviewed publications

700+

Convenings

400 million+

Lives impacted

11

Union ministries supported

20+

State governments supported

SPECIAL INITIATIVES

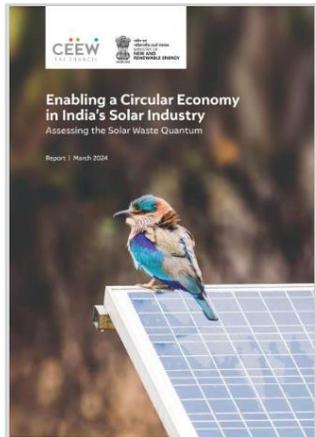
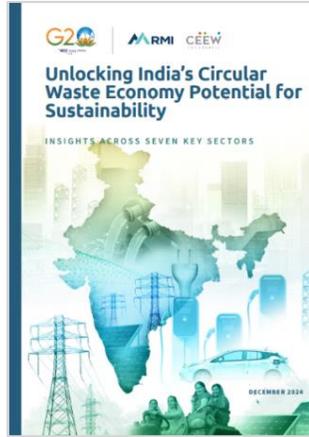
CEEW Green Finance Centre

Powering Livelihoods

Emerging Economies

UP State Office

CEEW's journey in solar circularity: Generating evidence and creating dialogue to drive policy and industry decisions



List of publications on solar circularity by CEEW



National Dialogue on solar circular economy



First Industry Roundtable on Circular Economy in Solar in 2022

नवीन एवं नवीकरणीय ऊर्जा मंत्रालय
MINISTRY OF NEW AND RENEWABLE ENERGY

75 Azadi Ka Amrit Mahotsav

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Call for Proposals on Innovation Challenge for Circularity in Renewable Energy Technologies – Batteries and Solar Photovoltaic

Title	Description	Start Date	End Date	File
Call for Proposals on Innovation Challenge for Circularity in Renewable Energy Technologies – Batteries and Solar Photovoltaic	Call for Proposals on Innovation Challenge for Circularity in Renewable Energy Technologies – Batteries and Solar Photovoltaic	23/06/2025	15/07/2025	View (548 KB)

Knowledge partner to MNRE for the Innovation Challenge



By 2047, India's cumulative solar waste would increase to 11 million tonnes, presenting an opportunity to enhance energy security, attract investments and create new jobs

Material
security

38%
raw material demand
met by recycling

Reduces import
reliance

Economic
growth

INR 3,709 crore
market opportunity

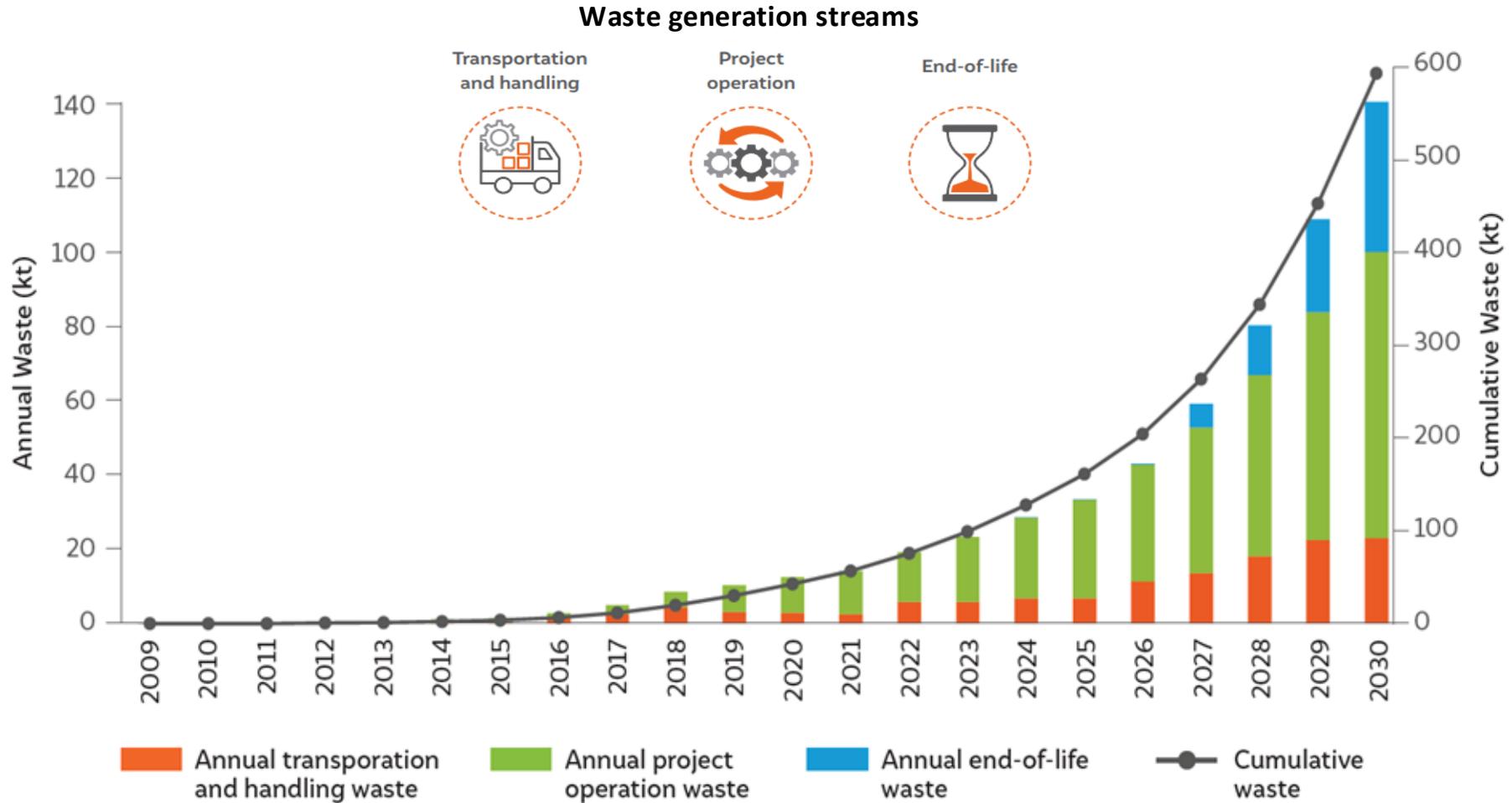
Creates new
industries and
jobs

Emission
savings

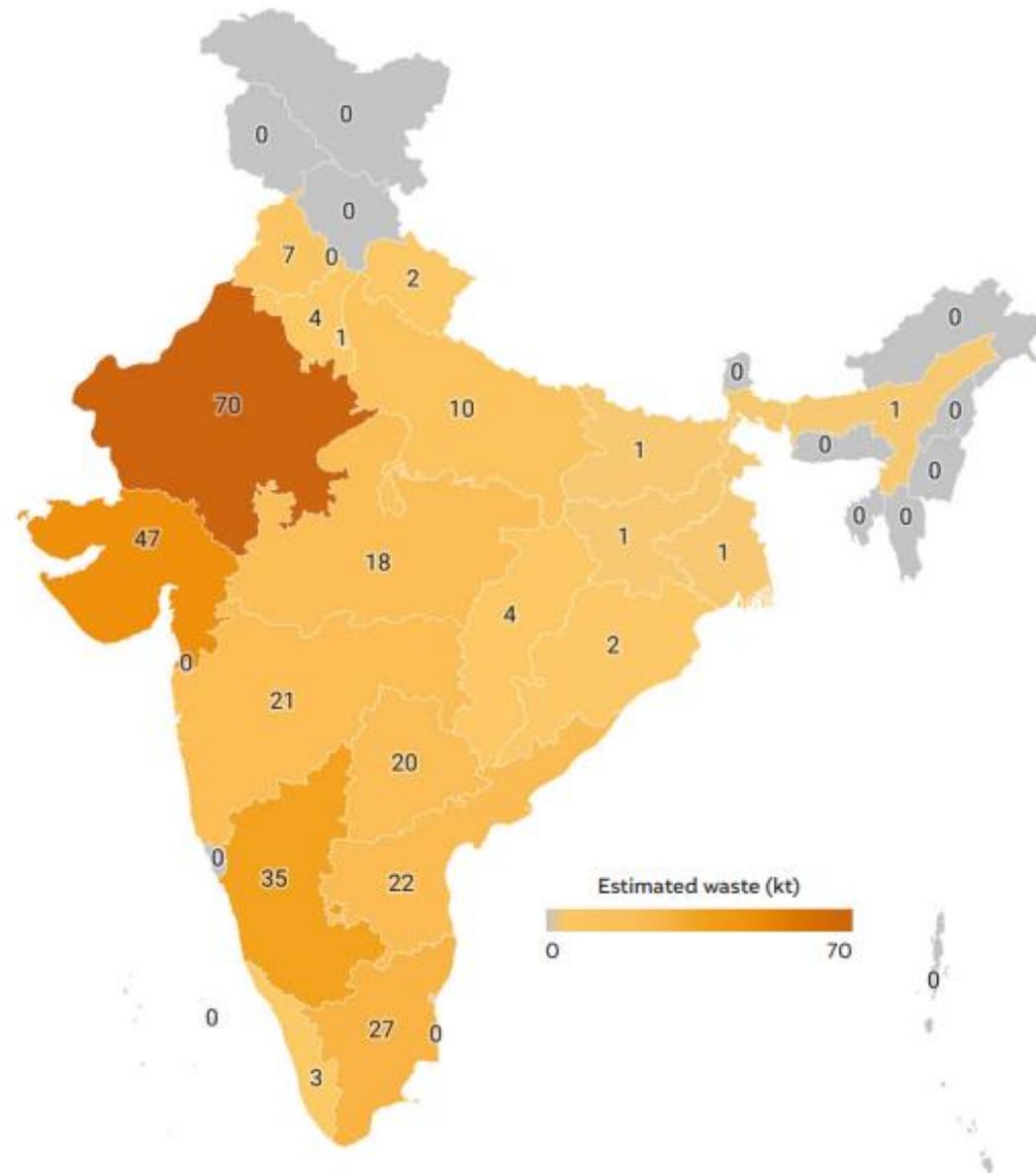
37 million tonnes
of CO₂ equivalents
emission avoided

Lowers waste
and lifecycle
impacts

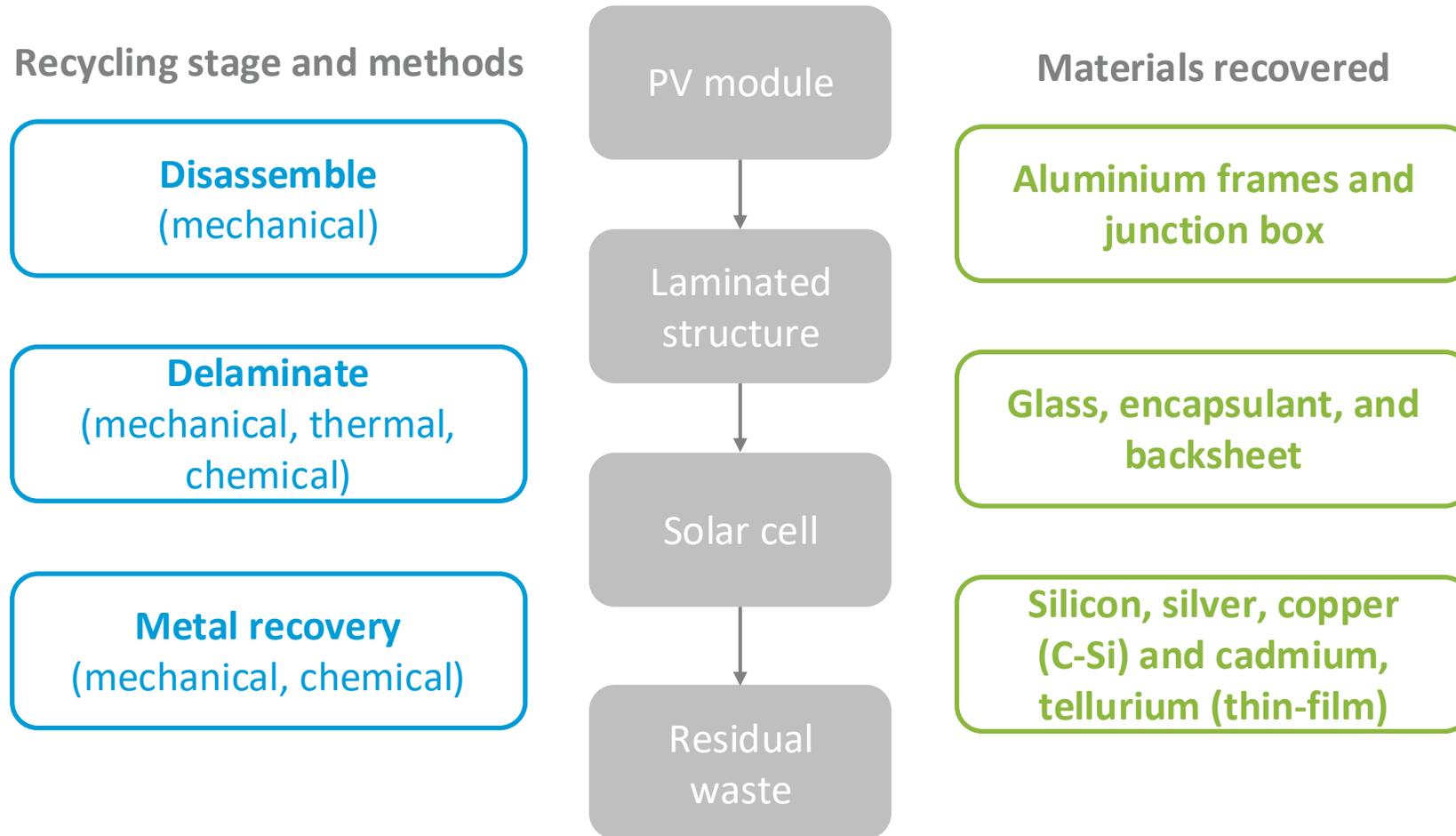
By 2030, India's solar waste is estimated to reach 600,000 tonnes with non end-of-life dominating the waste profile



67% of the cumulative solar waste is expected to originate from five states



Mechanical recycling enables initial material recovery, while chemical processes unlock deeper extraction of metals from solar waste



But module recycling in its current setup is financially unviable due to high operating costs

Mechanical recycling

~40,130
INR/tonne

Recurring costs
High waste
procurement and
processing costs

~29,900
INR/tonne

Benefits
Sale of lower-
grade materials

~10,230
INR/tonne loss

Chemical recycling

~49,060
INR/tonne

Recurring costs
Higher due to use
of chemicals

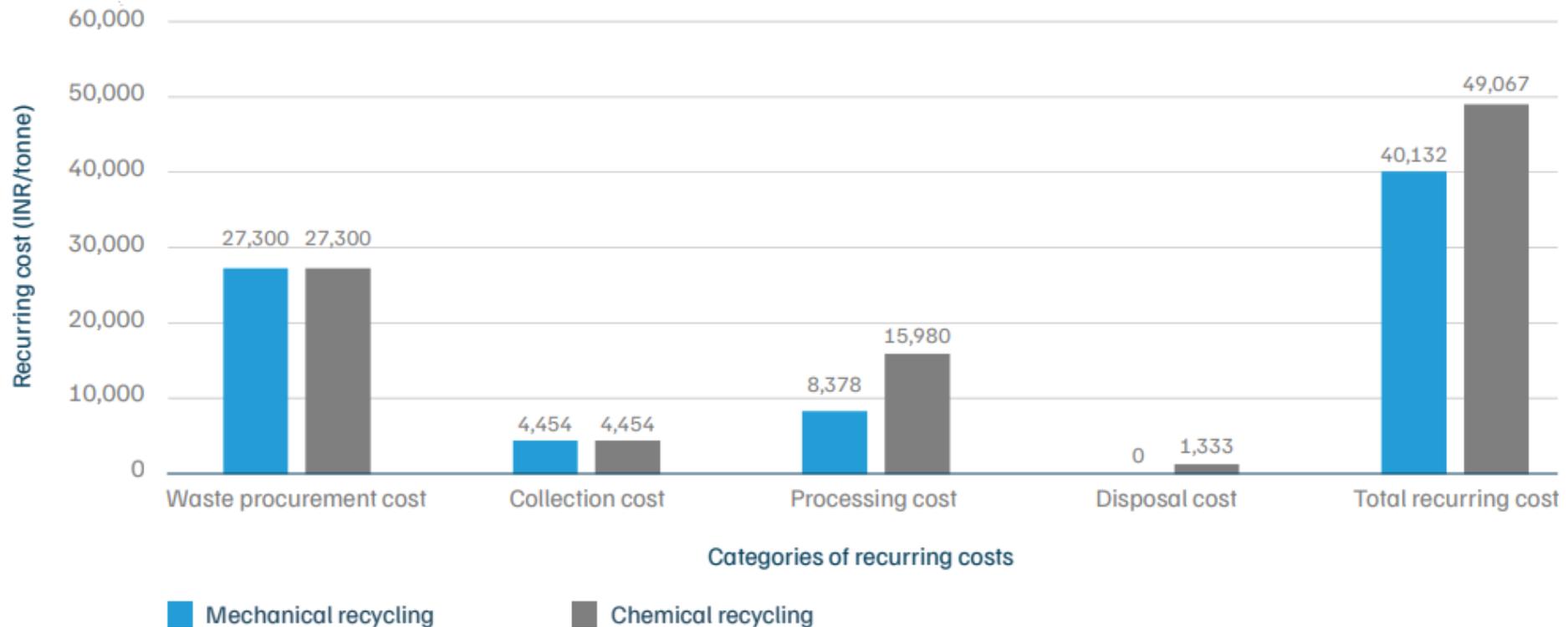
~36,720
INR/tonne

Benefits
Sale of high purity
silicon and silver

~12,340
INR/tonne loss

- Recurring costs: waste procurement, collection, processing – workforce, power, maintenance, and material, and disposal
- Financial benefits: sale of recovered materials

Module procurement accounts for the largest share, 56–68%, followed by processing and collection costs



- If waste solar modules are available free of cost, mechanical recycling would generate a revenue of INR 17,000 per tonne and chemical recycling a revenue of INR 15,000 per tonne.
- Or, procurement costs must come down from INR 600 to INR 330–375 per module for recycling to break even.

EPR certificate trading under India's regulatory framework can turn module recycling profitable



- EPR credits can be generated for 4 metals – gold, copper, aluminium, and iron.²
- Only 2 are eligible for solar waste - iron and aluminium.

Selling of EPR certificates turns **solar module recycling profitable**

- **~INR 9700 per tonne or INR 215 per module** profit

Globally, the solar industry including manufacturers, recyclers, and researchers are actively advancing circularity initiatives

Trina Solar Announces World's '1st' Fully Recycled Solar PV Module

Up To 20.7% Efficiency & More Than 645 W Output For Recycled TOPCon Panel

Sep 09, 2024

Solarcycle to supply Heliene with glass made from recycled solar PV modules

Solarcycle will sell at least 20 million square meters of recycled glass to Heliene over the next five years.

SEPTEMBER 12, 2024

First Solar: Recovering Minerals & Metals from Solar Waste

August 14, 2025

More PV manufacturers expected to adopt copper metallization in 2026

JANUARY 22, 2026

Liquid Encapsulation: A Route To More Circular Module Design

Researchers from Delft University of Technology and Biosphere Solar propose a liquid encapsulation approach that enables easier module disassembly

Jan 29, 2026

German startup offers refurbished solar modules in balcony PV systems

DECEMBER 6, 2024

India is witnessing regulatory reforms and policy support to build a local recycling industry; manufacturers must also step up

- **More regulatory clarity**
 - Introduction of EPR targets, extending scope of certificates to all metals found in solar modules
- **Promotion of technology development and demonstration**
 - Innovation challenge, incentive scheme for recyclers
- **Design circular products**
 - Use alternate materials for encapsulants for easy recycling, reduced use of adhesives for easy disassembly
- **Use recycled materials in new modules**
 - Recycled glass, aluminium, copper, silicon, and silver
- **Establish closed loop business models**
 - Product as a service

Thank you

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